POWER

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Firemen—and Firemen

By H. E. Hopkins

[At the recent locomotive firemen's hearing in New York it was said that firemen now work harder than formerly and are not paid proportionately; that on a hundred mile run over 20 tons of coal are handled; that their clothing was scorched by the intense heat; that 14 hours was the average run; that as the Mallets did more work than the older types many engineers were compelled to go back to firing or be laid off.—News report.]

WHEN you're feelin' sort of peeved
'Bout the wages you are gittin',
An' you think your lot's so tough
That your job you'll soon be quittin'—
Ask the fireman on a Mallet
How his trick compares with yours.
Then you'll find what you call tough
Don't be nothin' else but "chores."

If you'd run a hundred mile,
An' you'd scooped up twenty ton;
If you'd bucked a hu kin' fire
On a fourteen-hour run—

If your overalls an' pants
Was aburnin' from the heat—
If your feet was puffed an' blistered
An' you felt wel-nigh dead beat—

If you'd pulled old Ninety's throttle
In her cab for seven years
An' the Old Man laid you off—
Said that Mallet engineers

Did the work of two of you—
If to firin' back you went
'Cause 'twas all that you could get,
An' the wife, the kids, the rent—

If just sixty bucks a month
Was the pay for all this labor—
Then! You'd have more cause for grumblin',
Ain't I right about it, neighbor?
I'm not sayin' both ain't hard,
But there's reason to be glad,
'Stid of grouchin' 'bout your job,
When there's worse that might be had.

Commonwealth Edison Co.'s New Station

SYNOPSIS—A mammoth station which will eventually have a capacity of 240,000 kw. As at the Fisk St. station, the unit plan has **been adopted,** *each unit consisting of ten B. & W. boilers* **and** *one 20,000 kw. Curtis turbine. Two machines have now been installed, and as the load demands other units will be added.*

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The newest generating plant of the Commonwealth Edison Co., of Chicago, known as the Northwest Station, is located on a 55-acre tract of land bounded north and south by Addison and Roscoe Sts. and east and west by the north branch of the Chicago River and Sacramento Ave. and North Whipple St. Two blocks west the company has acquired an additional 40 acres, adjoining the tracks of the Chicago and Northwestern Ry., which are to be used as the main coal-storage field for the plant. The location of the plant is a logical one, as it affords the greatest fuel-delivery advantages and the best condensing-water supply compatible with moderate real-estate values and economical distribution of current.

A private electrically operated railway connects the Northwestern tracks, the main coal-storage field and the power houses themselves. Sixty-ton electric locomotives, furnished by the General Electric Co. and of the same type as those employed by the New York Central R.R. for suburban work at New York City, are used for hauling in the coal cars and switching them about the property.

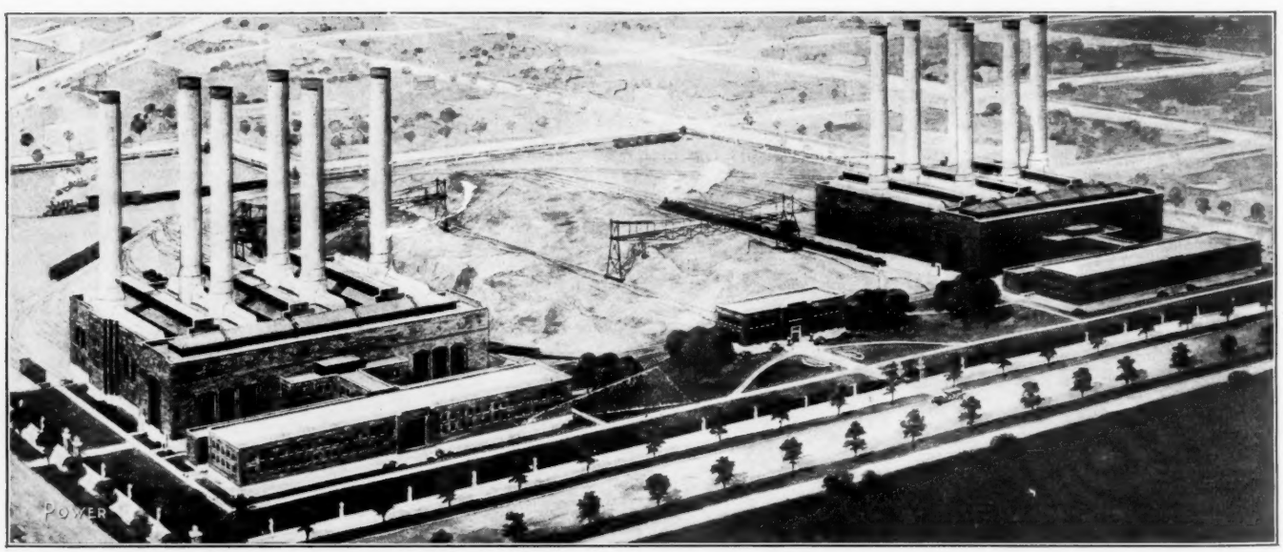


FIG. 1. ARCHITECT'S LAYOUT OF THE NEW NORTHWEST STATION

As a precaution against complete interruption of service, the station will be divided into two groups of buildings with an ultimate capacity of 120,000 kw. each. Fig. 1 shows how they have been laid out. The low buildings at the front of each group are for the transformers, high-tension busbars and oil switches. These connect through a covered passageway with the generator house and beyond the latter is the boiler house. Between the two groups will be two coal piles, each served by a gantry crane having a 265-ft. span.

At present only two-thirds of the group of buildings shown at the left in Fig. 1 have been completed and two 20,000-kw. Curtis vertical turbo-generators with the required boilers and auxiliaries have been installed and are now in service. The present plans provide for six such units in each generator house, but, due to the remarkable and rapid progress being made in the design of prime movers, it is quite likely that the completed plant will be considerably different from that for which the plans now provide. The station is laid out on a unit system closely similar to that employed at the company's Fisk St. plant. Each turbine is served by its own group of 10 boilers, which lie in a row at right angles to the longitudinal center line of the generator house, as shown in Fig. 4, which is a plan of the partly completed station and the existing equipment. The boilers for units Nos. 1 and 2, 3 and 4 and 5 and 6 face each other across a wide firing aisle, as shown in Fig. 2, so that one crew of firemen and water tenders can take care of two groups.

Each boiler is capable of economically generating 30,000 lb. of steam per hour. Thus, each group is ample to supply its generator under maximum load and still be large enough to spare a boiler for cleaning or repairs. The boilers are of the standard B. & W. design and each contains 5800 sq.ft. of heating surface. The superheaters, located between the first and second pass, are also of the standard B. & W. design.

The boilers are set with a high-combustion chamber. The coal is burned on B. & W. chain grates, which have an area of 115 sq.ft., giving a ratio of grate surface to heating surface of 1 to 50.4. Steam is generated at 250 lb. pressure and superheated 125 deg. F. Each group of boilers is served by its own steel stack, 250 ft. high, above the boiler-room floor, by 17 ft. inside diameter.

One separate and complete coal-handling system is employed for each two groups of boilers. Coal either direct from the mine or from the company's coal-storage piles is run into the boiler house in cars at grade level underneath the fire-room floor, the latter being some 22 ft. above the ground line. The two tracks provided, as

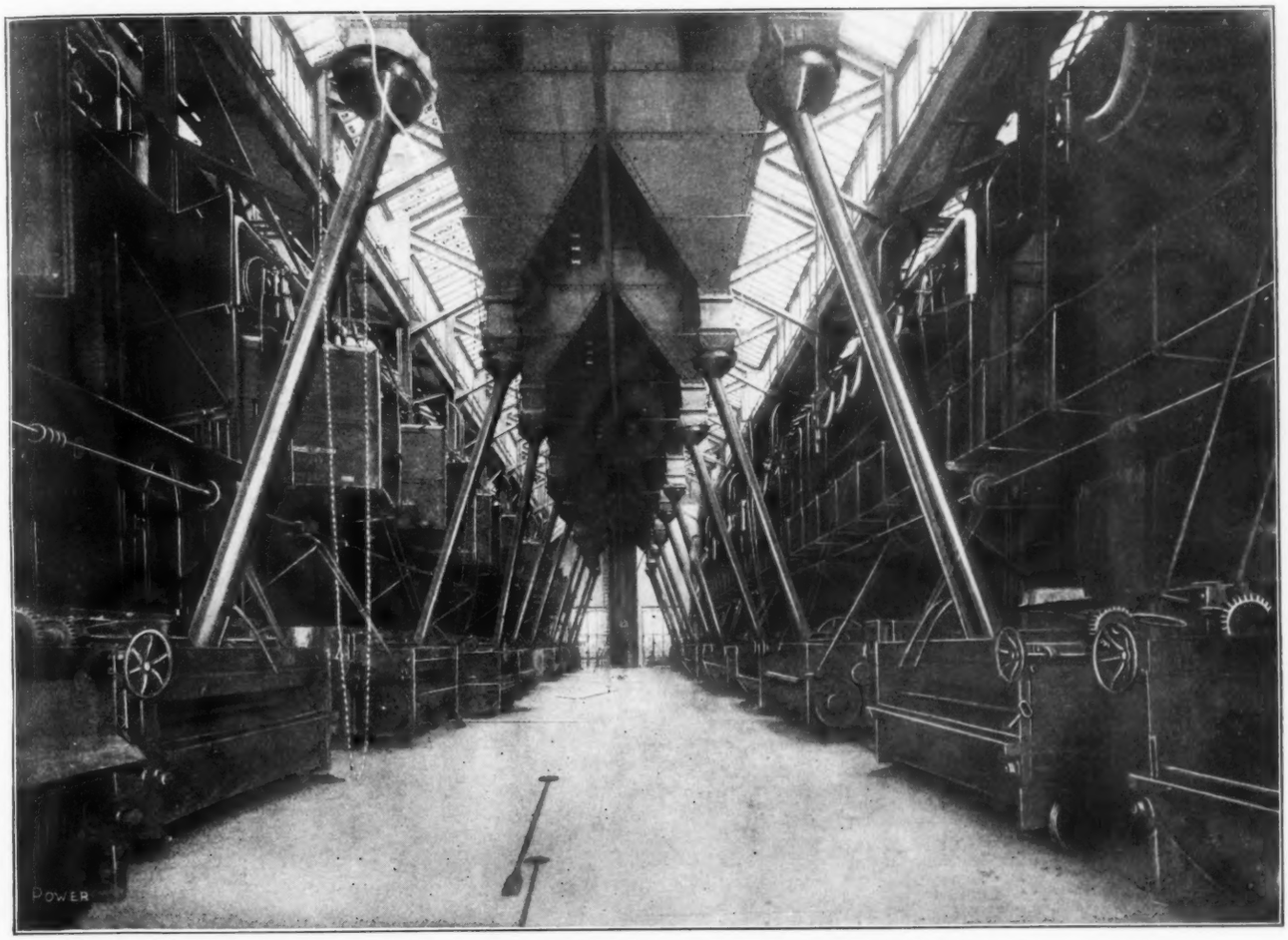


FIG. 2. PRESENT EQUIPMENT OF 20 BOILERS SERVING THE TWO 20,000-KW. TURBINES

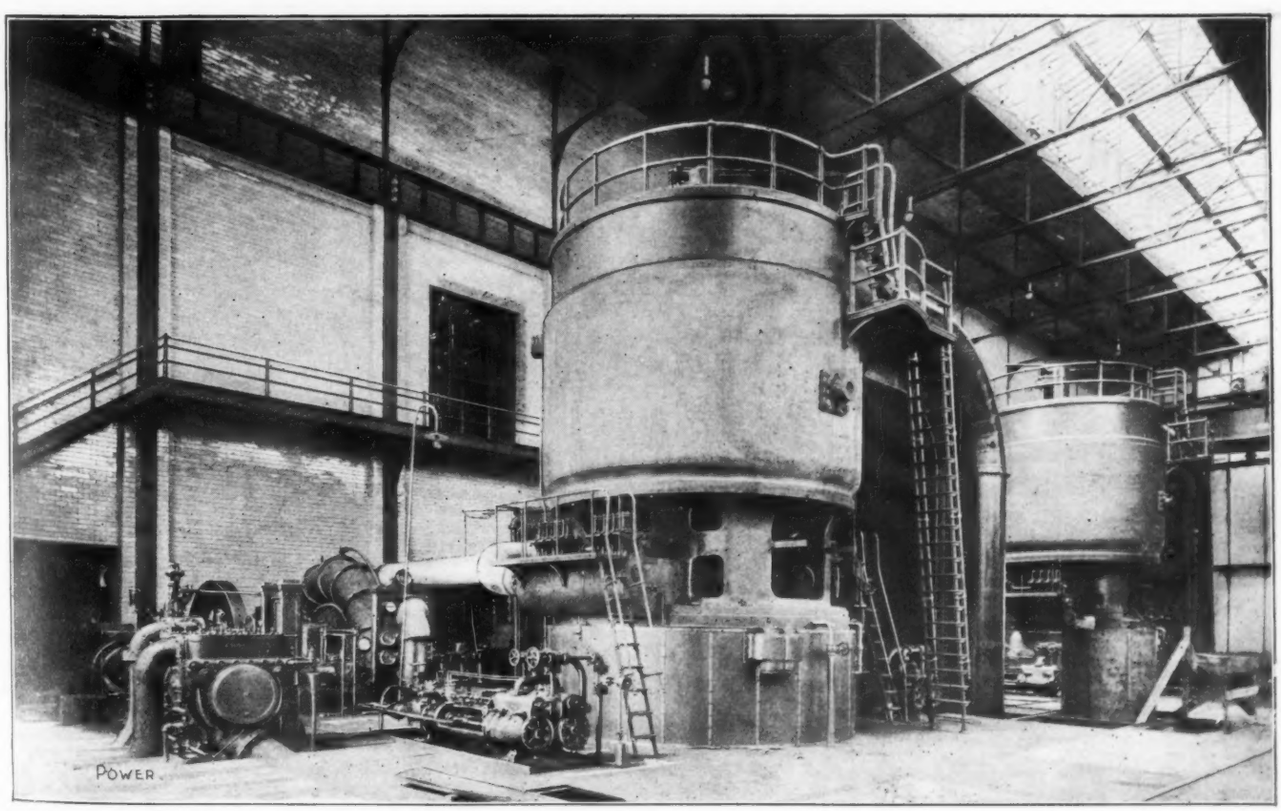


FIG. 3. THE TWO 20,000-KW. SIX-STAGE CURTIS TURBINES AND AUXILIARIES

shown in Fig. 6, bring the cars directly over a reinforced-concrete hopper and thus the dumping type of car can be unloaded into the hopper direct. The nondumping cars are unloaded by a traveling crane and a 2-cu.yd clam-shell bucket which drops the coal through an opening provided between the tracks. From the receiving hopper the coal is fed into a traveling crusher which runs on tracks directly over the 34x36-in. buckets of a conveyor. The conveyor raises the coal and deposits it in overhead bunkers located directly over the firing aisle, as shown in Figs. 2 and 6, and from these it is fed through spouts to the stoker hoppers.

The fine coal which sifts through the grates falls through spouts back into the receiving hopper and is again raised to the overhead bunkers by the conveyor. The ashes falling off the end of the chain grates are caught in ash hoppers below, which have a capacity for one day's accumulation. Railroad cars for receiving the ashes are run in under the hoppers and the latter are emptied once each day.

The turbines, shown in Figs. 3 and 5, are of the standard Curtis six-stage vertical type, rated at 20,000 kw. The speed is 750 r.p.m. The exhaust steam drops directly into a Worthington base-type surface condenser containing 7600 one-inch tubes, 17 ft. long, which have a cooling surface of 32,000 sq.ft. The circulating water is drawn from the Chicago River through the lower portion of the double concrete tunnel, as shown in Fig. 5, and discharged through the upper portion This tunnel is large enough to serve all six units in the station. The circulating-water pump for each unit is a 36-in. volute with a capacity of 40,000 gal. per min. against a total head of 20 ft. It is driven by a 20x30-in. Corliss engine at a speed of 120 r.p.m. The dry-vacuum pump is driven by this same engine, the cylinder being arranged in tandem with that of the engine. The vacuum-pump cylinder is 28x30 in. in size. The condensed-water pump is a 5-in. Worthington horizontal two-stage centrifugal driven by a G. E. turbine and having a capacity of 660 gal. of water per minute.

The feed water comes from the condenser at a temperature of about 75 deg. F. and after passing through a closed heater located on the turbine floor and supplied with the exhaust steam from all of the steam-driven auxiliaries, is pumped to the boilers by either of two Worthington three-stage centrifugal pumps driven by Curtis horizontal steam turbines running at 2300 r.p.m. The capacity of each pump is 700 gal. per min. Makeup water supply is controlled by a float valve in the top of the heater.

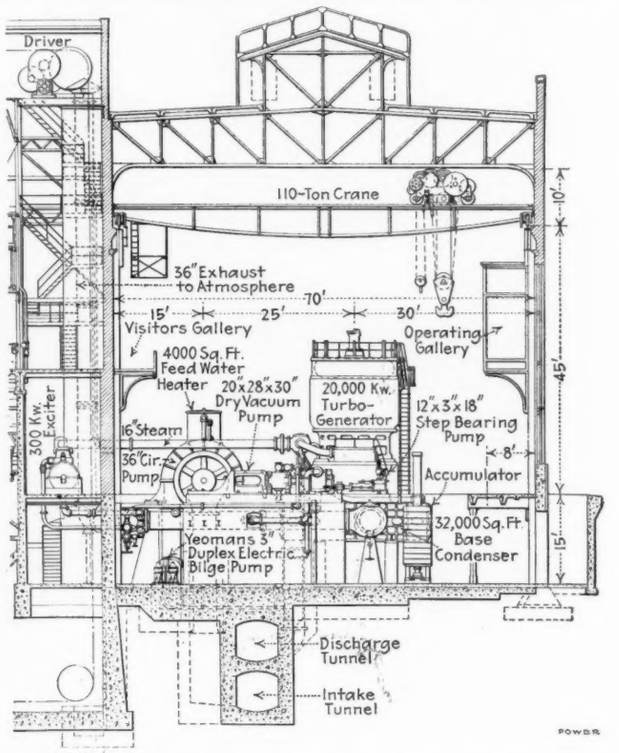


FIG. 5. TRANSVERSE SECTION OF GENERATING ROOM

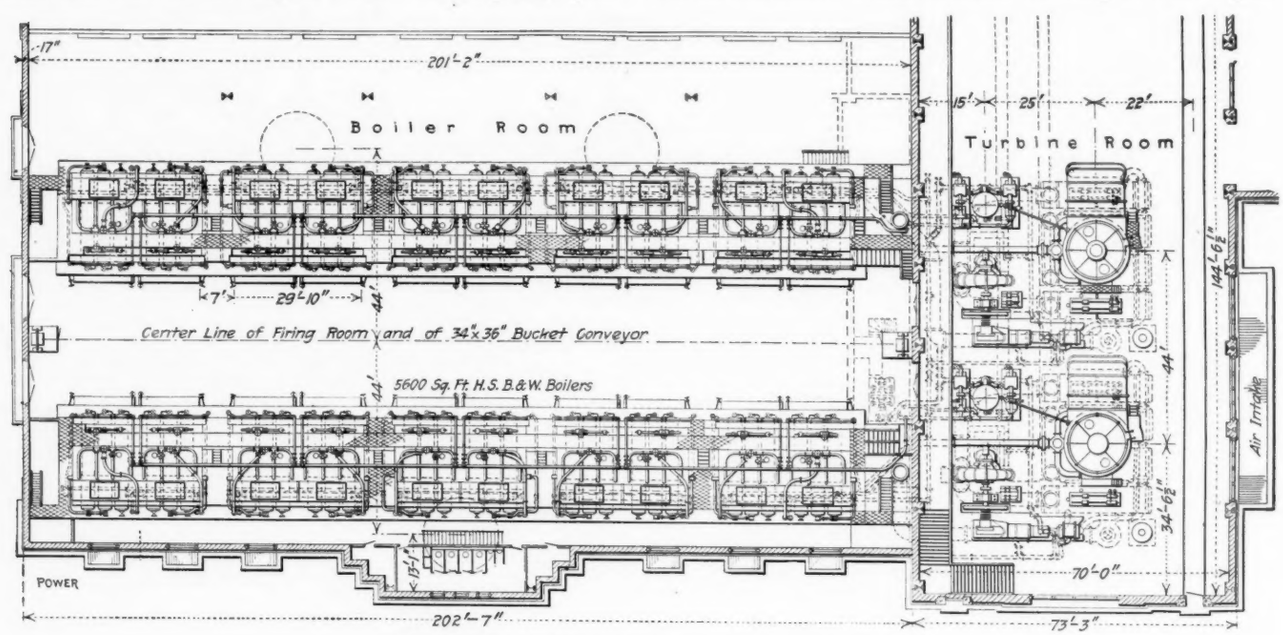


FIG. 4. PLAN VIEW OF PRESENT EQUIPMENT

Steam is withdrawn from the boilers through 6-in

extra-heavy leads which connect with a 16-in. header for each set of boilers. This header is supported on rollers in a passage at the back of and below the boilers, as shown in Fig. 7. An 8-in. line connects the header of one unit with those of the others so that if need be the steam from one group of boilers can be supplemented with steam from another. The blowoff and boiler-feed

The generator room is finished in white enamel-faced brick and when completed will measure 290 ft. long, 70 ft. wide and 55 ft. high. A 110-ton Morgan Engineering Co. crane spans the room and a railroad track connecting with the outside system extends into the room so that new equipment literally can be delivered in the station.

The weight of the steam end of each unit is 200 tons

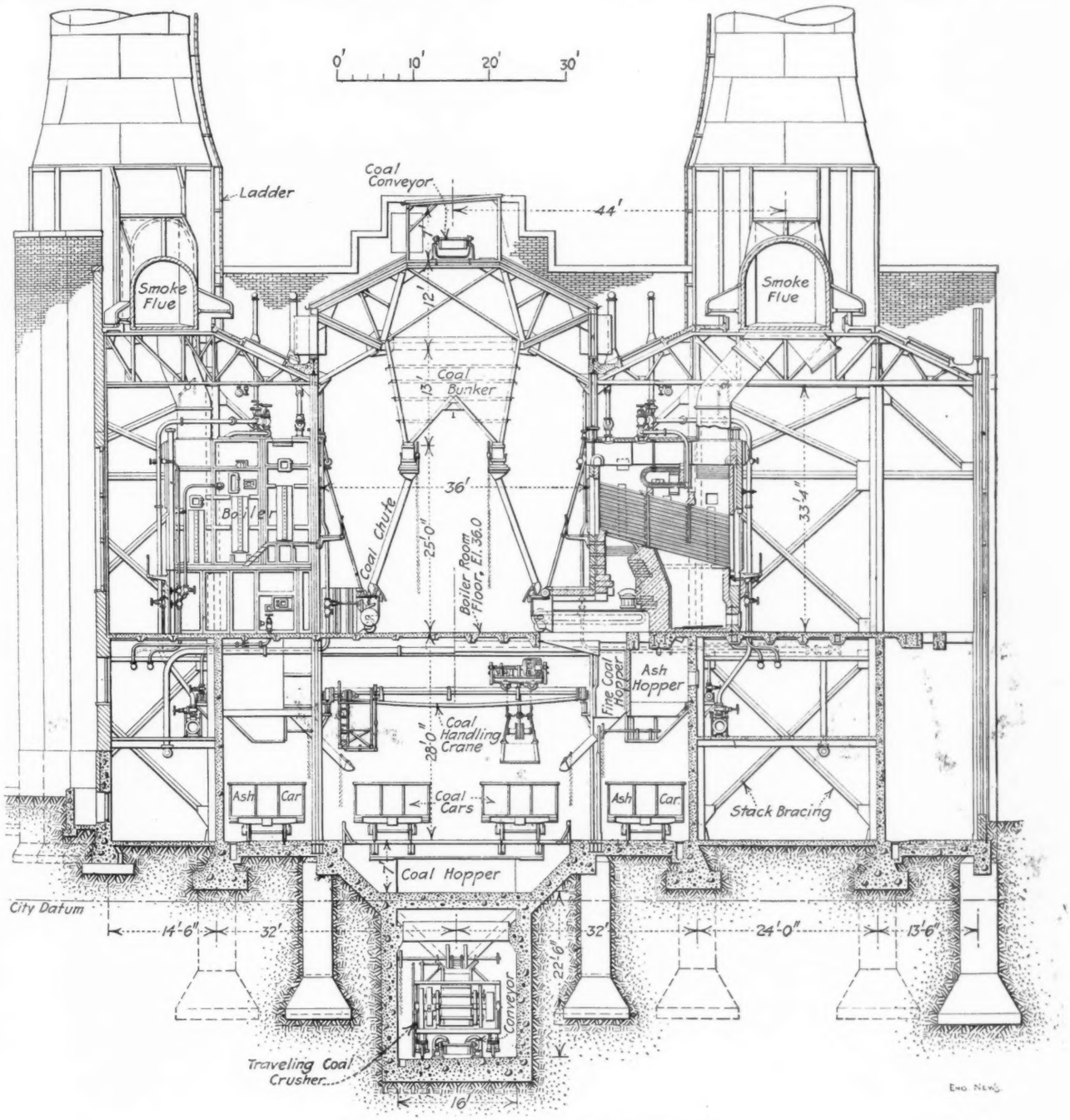


Fig. 6. Cross-Section of Boiler House

piping are also located in the passage mentioned. The safety valves of the boilers blow off through 6-in. risers extending to the roof, as shown in Fig. 8, thus eliminating the danger and discomfort of high-pressure steam discharging into the boiler room.

The current generated is three-phase, 25-cycle and 4500 volts. It is stepped up through autotransformers to 9000 volts for delivery to the substations.

and that of the generator end 230, making a total weight of 430 tons, of which 100 tons is in the revolving elements This great weight is supported by the step bearing, the two valves of which are kept apart from direct contact by oil forced into the bearing at a pressure of 800 lb. per sq.in. to which the pump pressure of 1200 lb. is baffled down. The step pumps are Worthington, 12 and 3 by 18-in., horizontal, duplex, double-acting, high-pres-

sure units. Floating on the oil system is an accumulator weighted to 30 tons. Should the accumulator sink to a predetermined level, owing to the failure of the steam pump, the auxiliary pump is cut into service automatically.

Forced ventilation of the generator parts is provided by a fan mounted on the main shaft above the generator. The air for this purpose is drawn from the outside of the building through a duct.

In the completed station there will be four exciters, two of 300 kw. capacity each, driven by Curtis horizontal two-stage turbines running at 1500 r.p.m. and generating current at 125 volts and two of 200 kw. capacity each, driven by alternating-current motors at 750 r.p.m In addition there will be two 70-cell storage batteries, each with 1000 amp.-hr. capacity.

The operating gallery is located in a bay projecting into the turbine room, and from here the operator has a clear view of the entire turbine-room floor. The generator-control switches are mounted on a bench board, Fig. 9, and the line-control switches and all instruments are mounted on vertical slabs above the bench board.

With the advent of the high-speed turbine it was found possible to build a generator whose reactance was only one-fourth or one-fifth of that of the lower-speed reciprocating-engine-driven generators. This was thought to be a highly desirable improvement and the utmost advantage was taken of the new design to keep the reactance as low as possible; but when such generators of large sizes were built and connected to a common set of busbars, it was found that nearly the whole energy stored in the high-speed revolving masses would be instantly hurled into any near-by short-circuit which occurred, the energy output of the machines for the moment being perhaps twenty times normal.

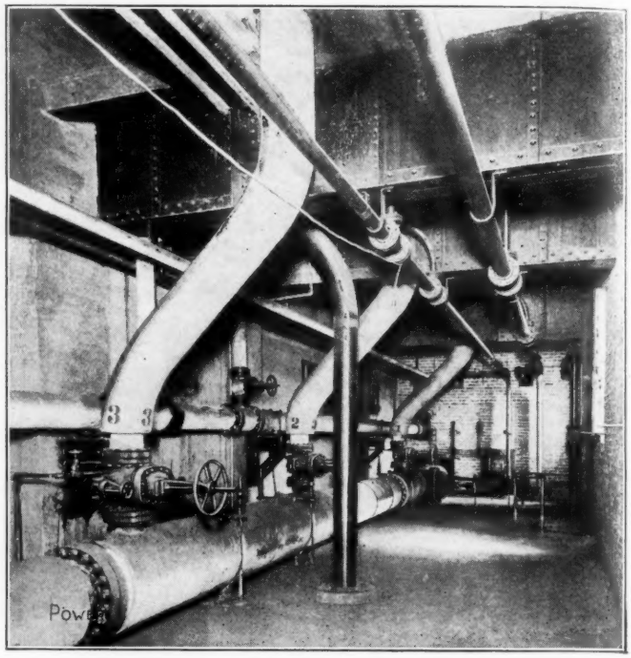


FIG. 7. MAIN STEAM HEADER AND BOILER CONNECTIONS

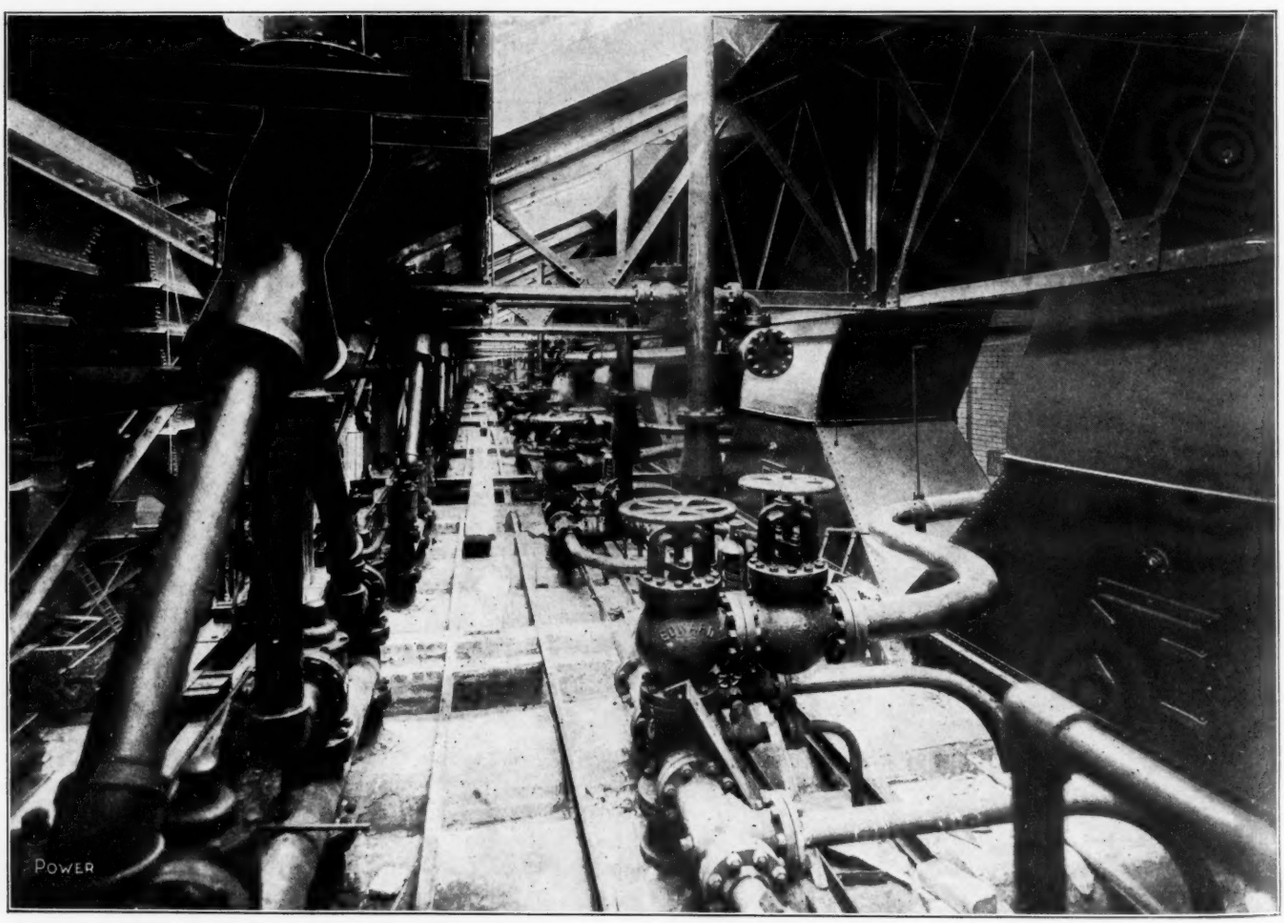


FIG. 8. VIEW ON TOP OF BOILERS

Such violent surges were so destructive to generators, switches, busbars, line and connected apparatus that it was found necessary to restore to the circuit nearly as much reactance as had been gladly eliminated. In the case of the Fisk St. machines this was accomplished by installing in each of the three armature leads to the busbar a 6 per cent. reactance—that is, a coil of cable supported on a concrete and wood frame, whose choking effect, together with the 2 per cent. reactance in the generator, at the full load of the generator, is equal to 8 per cent. of the voltage generated. This effect, which is unobjectionable at normal loads, increases with the square of the current flowing and, therefore, in times of trouble, affords protection which is ample and at the same time automatic. In fact, one of the 12,000-kw. Fisk St. generators was repeatedly short-circuited through a set of these reactances without harm to generator or coil.

At the Northwest station the additional reactance needed was introduced into the circuit in the autotransformers, which step up the pressure from the machine voltage of 4500 to the system voltage of 9000. These transformers are installed in a separate building between the turbine room and the switch house.

Each transformer is installed in a separate fireproof compartment and is of 3333 kv.-a. capacity. They are water and oil cooled and contain 1700 gal. of oil. Water is circulated through pipes immersed in the oil at a rate of 16½ gal. per min. Each tank has an emergency drain, by means of which it can be emptied of oil in a short time. The efficiency of these transformers is 99.4 per cent. at half load and 99.3 per cent. at full load.

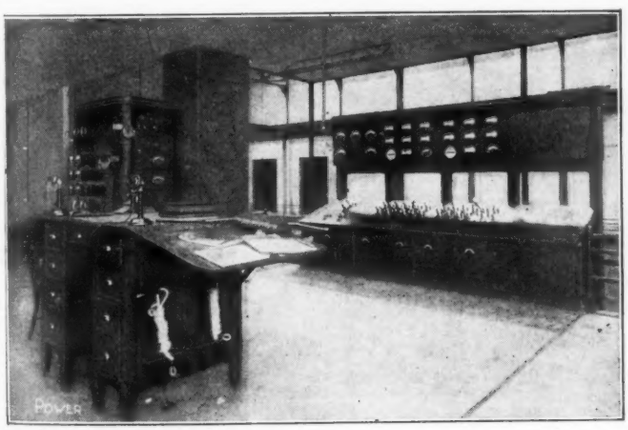


FIG. 9. CONTROL BOARD ON THE OPERATING GALLERY

They are 13 ft. high, 9 ft. long and 5 ft. wide and weigh, with the oil, 25 tons.

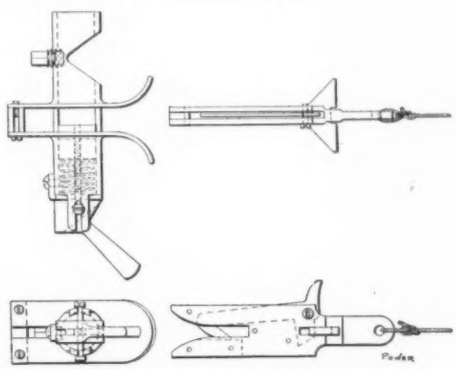
To the east of the transformer house is the switch house, a three-story building containing all the oil switches, high-tension busbars and instrument transformers. On the first floor the busbars, cables, bells and generator leads are installed. The line and generator busbars run east and west, and the main and auxiliary busbars north and south.

The second floor contains the oil switches, the pots of which are built in a single row instead of a double row, which arrangement provides greater safety, in that each oil pot is separated from the adjoining one by a concrete partition. Nineteen switches are provided for each unit, nine of which are bus and tie switches, and two generator switches.

Abadie Indicator Coupling

This device consists of a hollow, cylindrical body, fitted with a setscrew on one end to attach to a pin screwed into the engine-crosshead wristpin. The cylindrical body is made in two sections, joined in line with each other by two pins. The two sections are also separated by two guide plates, bent outward at the outer end to guide the hooking-on member, which is attached to the indicator cord. The outer part of the crosshead member is fitted with a fiber plunger operated by a lever; this is to clamp the hook member in place to prevent endwise movement.

The hook member is of double fiber strips with a metal hook pivoted at one end between the side pieces. The hook is made with a trigger against which the forefinger



INDICATOR-CORD COUPLING

rests when attaching the hook. A crosspiece, or releasing trigger, is also fitted in the body of the hooking member, which, when pressed forward, lifts the hook, disengaging it from the pin of the crosshead member. The details of the device are shown in the accompanying illustration.

When attaching, the plunger is raised by tipping the plunger lever. Then the hook part of the coupling is loosely held between the forefinger and the thumb, letting the hook trigger act as a shoulder against the finger or thumb. It is then advanced in line with the crosshead pin until the hook just touches the pin in the main member; then, by advancing it suddenly about one-fourth inch, the hook engages. Then the plunger lever is tripped back and a diagram taken.

When detaching, the plunger is raised by tipping the plunger lever in the opposite direction. The cord is straddled with two fingers, which are advanced until the releasing trigger is felt; then by advancing the hand one-fourth inch, the hook is released, as the trip trigger comes in contact with the fingers.

The device is the invention of Louis Abadie, Abbeville, La.

The college graduate is often alarmed at the success of the practical engineer who never went beyond the grammar schools while the college graduate, with medals galore, is still struggling in the ranks. The answer is found in the breadth of imagination, safe intuition and well-balanced judgment of the man who has been treading the practical paths.—"California Journal of Technology."

The construction of a dam and power plant on the Chelan River, in Washington, to cost more than $10,000,000, is planned by the Great Northern R.R. The road intends to propel its trains over the Cascades by electricity.

Troublesome Condensing System

By E. H. Lane

SYNOPSIS—Piping the siphon of each condenser to a common pipe equalized the water pressure and a check valve eliminated a troublesome water-hammer. Cross-connecting the water-supply pipes to the condensers reduced the number of circulating pumps operated before the change was made.

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Several years ago a large power house was built having a condensing system consisting of surface condensers A pump house was built at the river bank, about 2000 ft. distant. The pumps were of the single-stage, centrifugal, vertical type and were driven by induction motors. Hence, the speed and the head of water maintained were fixed, varying only with the stage of water in the river.

The first pump installation consisted of four pumps, one having a capacity of 4000 gal. per min., and three of 6000 gal. The three condensers each contained 10,000 sq.ft. of heating surface.

The pump house was connected to the power house by a 48-in. water line, running gradually up hill until the center of the pipe reached an elevation of about 31 ft. It then dropped gradually into the building, the center line of the pipe in the house being at an elevation of 22 ft. The top of the condensers was at an elevation of about 27 ft. and the water was connected at the bottom of the condensers, as shown at *A* in the illustration. The outlet was at the top at *B* and the overflow pipe *C* dropped about 10 ft. and entered the sewer *D* from the under side, as shown. This gave the condenser the benefit of about 10 ft. of siphon effect.

Starting the Condenser

In starting the plant it was customary to keep enough pumps running to maintain a sufficient head so that the water would pass through the condensers by virtue of the head in the pipe. When more water was used it became necessary to utilize the siphon effect of the tail pipe and it was found that one pump would supply the necessary water, as the effect of the 10-ft. siphon was the equivalent of 10 ft. more head with no additional work on the pump. In operation, however, everything would run nicely for a while when one condenser would take all of the water and the other condenser would lose the vacuum and the exhaust would go to the atmosphere. Then it was necessary to throttle the water on the condenser in service and raise the head enough to start the water through the other condenser.

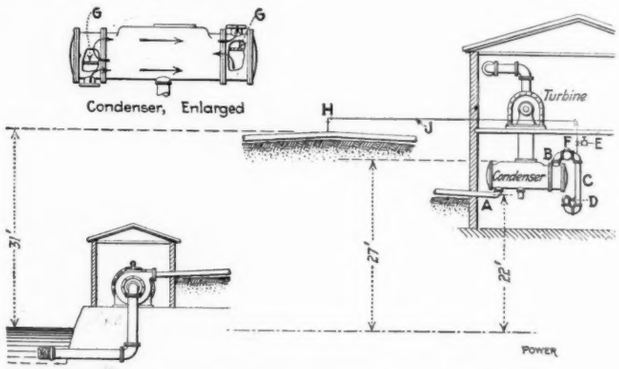
Usually when the water got started through the hot condenser a terrific water-hammer was set up in the siphon outlet and if a fitting was not split during the ordeal, the condenser would take all of the water as the circulating-water valve would be open more than the other and sometimes the condenser with the valve throttled down would lose its vacuum.

Changes Made

It did not take as long to overcome this trouble as it did for the chief to figure out how to do the job. The overflow or siphon of each condenser was simply connected with a 2-in. pipe, with a valve *E* at each connection, so that now the siphon effect on each condenser is the same, as the pressures are equalized by this pipe and the quantity of water is regulated by the head or inlet valve.

The water-hammer was stopped by putting a check valve *F* at the outlet of each condenser at the highest point, the check opening outward so that when more steam or air gets into the siphon than the equalizer can take care of, it blows out of the check. To start the water through a dead condenser, the inlet valve is opened the same amount as when running, and then the valve in the 2-in. equalizing pipe is opened. The water will then go through the condenser just as if the equivalent of the siphon effect in the head was added to the inlet side of the condenser. The condensers were of the single-pass type; that is, the water passed through them once and then to the sewer.

It was found, that, owing to the slow velocity of the water, mud and sand would accumulate in the tubes and it was not long before there was trouble. The chief put



Pump, Piping and Details of Condenser Installation

baffles-plates in the water boxes of the condenser and made each condenser a three-pass unit. Thus the same quantity of water, to get through the condensers, had to travel at three times its former velocity and this made them better condensers.

Everything seemed to be all right and the chief thought he had the condensers anchored and grouted.

Decreased Water Supply

About this time the river began to fall and the pumps obtained water by suction with the usual attendant air leaks. It was then necessary to run all of the pumps to supply the condensers with water. While the drop in the river level would necessarily decrease the quantity of water pumped, the head at the pump house continued to increase and the head at the plant to decrease.

Finally, the chief drilled and tapped a hole for 1-in. pipe in the highest point in the 48-in. pump line and considerable air escaped. At the same time the head at the pump house decreased and the head at the power house increased until finally one pump would supply the condensers with cooling water. A 1-in. line was run from the top in the 48-in. line at *H* and was connected to the 2-in. equalizer line between the condensers.

A connection was also made to one of the condenser air pumps so that any excess air could be quickly taken care of.

It will be readily seen that all air discharged from the centrifugal pumps would naturally accumulate in the highest point of the 48-in. line at *H*. The only way to get rid of the air would be to draw it out from the high point or get enough head at the pump house to compress it and drive it down through the 22-ft. elevation and out through the condensers, which would be practically impossible at the low stage of the river. Why the trouble happened at the low stage was probably because the pumps leaked more air with a long suction lift than otherwise, also that the head was insufficient to drive it out.

More Trouble

Everything seemed to be all right and there was no more trouble until last winter, when the river got low again and there began to be a difference of from 4 to 10 ft. in the water head of the pump house and the power-house head. The 1-in. air line was tested and as it was apparently open it was naturally concluded that it was a friction head, because the pump house had now to supply water for nine condensers of 10,000 sq.ft. of heating surface, take care of 33,000-kw. load, and run one 4000-gal., three 6000-gal. and two 10,000-gal. pumps.

Under these conditions the head at the pump house was 34 ft. and at the plant 25 ft. As a new 48-in. line was being installed alongside of the old, the 2-in. air line was run from the pump in the new line and connected to the equalizer line in the house by the pipe *J*. At the same time it was thought best to run a 1½-in. line over to the old 48-in. line, as perhaps the 1-in. line was a trifle small.

Less Pumps Required

As soon as the 1½-in. line was connected it was found that two 6000-gal. and one 10,000-gal. pumps would maintain a 28-ft. head at the power house, and only 31 ft. at the pump house, thus increasing the capacity of the pumps that much and supplying nine condensers.

Apparently the pump-house power consumption had been cut in two, but such was not the case. A certain amount of water was pumped before and the same amount is being pumped now, therefore, the foot-pounds of work done is the same. The accumulation of air in the hump of the discharge pipe was only the equivalent of a 48-in. valve shut just about so much, and it is one of the characteristics of centrifugal pumps that, as the discharge pipe is choked off, the work of the pump decreases. Thus the work done in either case was about the same, except that, since the discharge was partially closed by this air, it was necessary to run more pumps to maintain the head at the power house. Conversely if the river gets high, a little throttling on the discharge at the power house is necessary or the pumps would take on enough work to damage the motors.

The Flower Motor Ship Co., Ltd., a $5,000,000 company formed in London to operate lines of cargo vessels propelled by oil engines, has already placed contracts for vessels of 6000 tons for cargo only at present, and contemplates the establishment of regular sailings as soon as the boats are ready.

New Bundy Tilting Hot-Water Pump

This new hot-water pump is designed to handle water of condensation at a very high temperature, and at the rate of approximately 2 ft. for each pound of steam pressure admitted to the bowl.

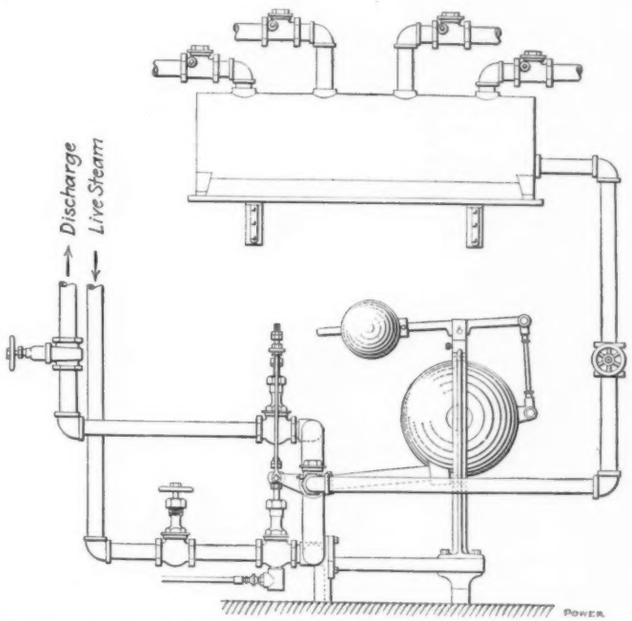


Fig. 1. Bundy Tilting Pump and Tank Connections

When piped, as shown in Fig. 1, condensation may be taken from exhaust-steam lines, returning at atmosphere or below, and raised to any height, discharging into a receiver, heater, hotwell or to a boiler return trap.

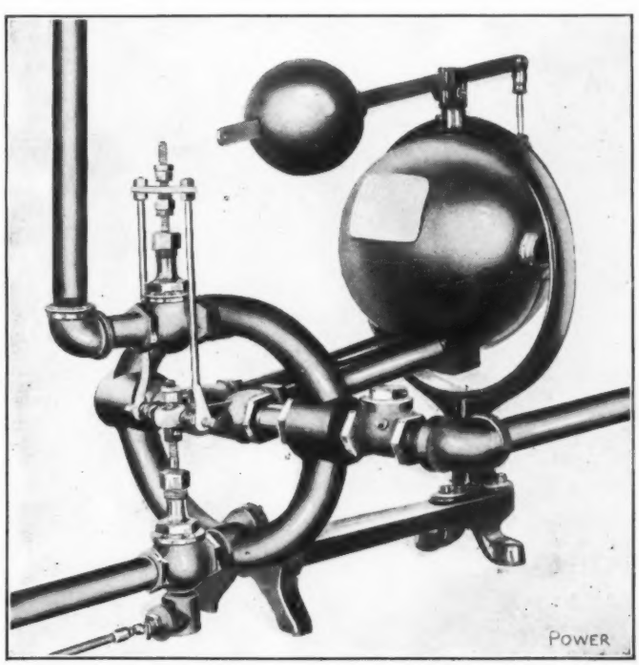


Fig. 2. Bundy Tilting Pump

This pump trap is also adaptable to picking up water from coils or other condensing surface located at a distance from, and returning it back to the boiler room. It is best to place a receiver, in which the water collects,

above the trap, as the water will flow to the pump trap.

The pump trap is designed as shown in Fig. 2. The yoke, usual on tank and return traps, is made with an extension on the upper side, so that the yoke approaches a ring in shape, as shown in the semi-sectional view, Fig. 3. The upper section of the yoke is connected to a discharge valve operated by the tilting of the bowl in unison with the lower, or steam valve. The latter has a vent, as shown in Fig. 2. Referring to Fig. 3, water enters the trunnion *A* in the direction of the long arrow. Live steam is admitted to the bowl through the valve *C* and the left-hand passage of the hollow trunnion. The discharge water passes from the right-hand trunnion in the direction of the short arrows to the discharge valve *B*; the same trunnion is used for the inlet and discharge water.

The operation of the pump trap is understood by referring to the pipe connections in Fig. 1. The water to be handled by the pump trap is returned to the receiver and flows by gravity to the bowl of the trap through the check valve. When the bowl is full of water it tilts to its lowest position, which action opens the steam and discharge valves. Live steam, therefore, rushes into the bowl and the water, being under steam pressure, is forced out through the inlet passage, but, being prevented from returning to the receiver by the check valve, passes through the upper part of the yoke, the discharge valve and the discharge pipe.

As soon as the water has been discharged from the bowl the weight brings it back to the filling position, which action closes the steam and discharge valves, when the cycle of filling and discharging is repeated.

This pump trap is manufactured by the Nashua Machine Co., 127 Federal St., Boston, Mass.

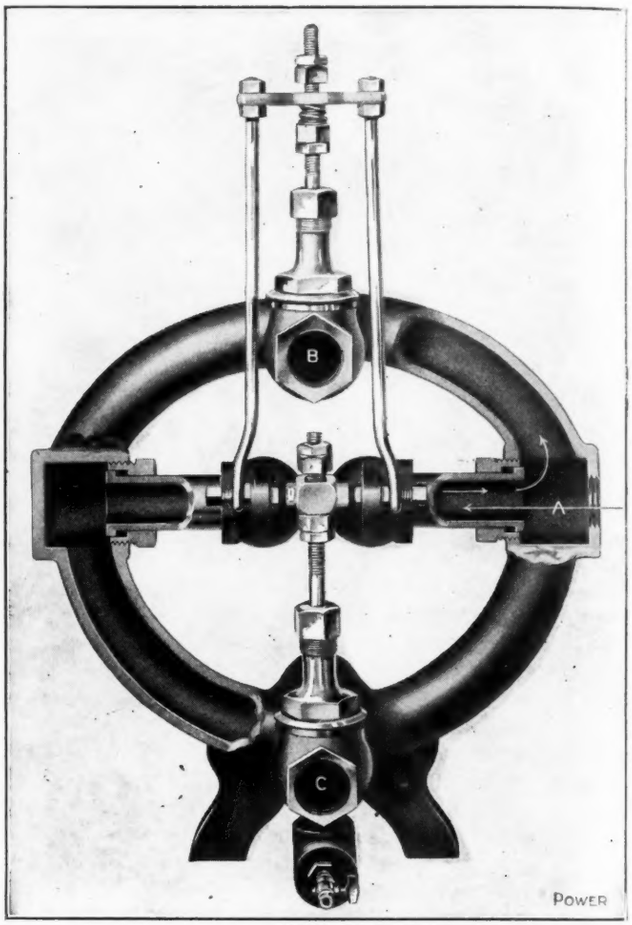


FIG. 3. ARRANGEMENT OF TRUNNIONS AND VALVES

Power Plant Log Calculator*

BY WALTER N. POLAKOV

SYNOPSIS—The construction of the calculator with full directions for its use.

Several years ago, when consulting engineer to the Board of Estimate and Apportionment of the City of New York, I was confronted with the problem to develop a quick and reliable method of figuring the results of boiler trials, efficiency of operation and cost from daily plant logs. The result was the calculator illustrated herewith.

The instrument consists of a logarithmically divided disk (inner scale) centrally revolving on a similarly divided dial (outer scale). The divisions are from 1 to 10 and any multiple of 10. Additional graduations are made for constants for the determination of the thermal efficiency when fuel of different heat value is used. On the outer scale of the dial graduations are made which are constants for the determination of the cost of fuel for the generation of 1000 lb. of equivalent steam. They are based on the cost of 1,000,000 B.t.u. Equivalents for ready interpretation of horsepower and kilowatts in heat units and cubic feet of water at various temperatures into pounds are also marked on the disk and dial. In the center of the disk is a diagram for the determination of the factor of evaporation for saturated dry steam. Instructions for the use of the chart follow:

Weight of Feed Water—Set 10B opposite the Wilcox water meter reading found on the dial. The result in pounds appears on the dial opposite the feed temperature marked on the disk.

Cubic Feet into Gallons—Set 10B opposite the number of cubic feet on the dial. The result in pounds appears on the dial opposite the observed temperature.

Steam Consumption per Kilowatt-hour or Horsepower-hour—Set the kilowatts or horsepowers of output on the disk opposite the number of pounds of steam consumed, read on the dial. The result in pounds per kilowatt or horsepower-hour appears on the dial opposite 10B of the disk.

Fuel per Unit of Output—Same method as above.

Actual Evaporation—Set the number of pounds of fuel, read on disk, opposite the number of pounds of water evaporated, on the dial. The result appears on the dial over 10B of the disk.

Factor of Evaporation—Find feed-water temperature at the left of the diagram in the center of the chart and

*Copyrighted, 1913, by Walter N. Polakov.

follow the horizontal line to its intersection with the diagonal line representing gage pressure; then follow the vertical line down and read the factor of evaporation at the bottom.

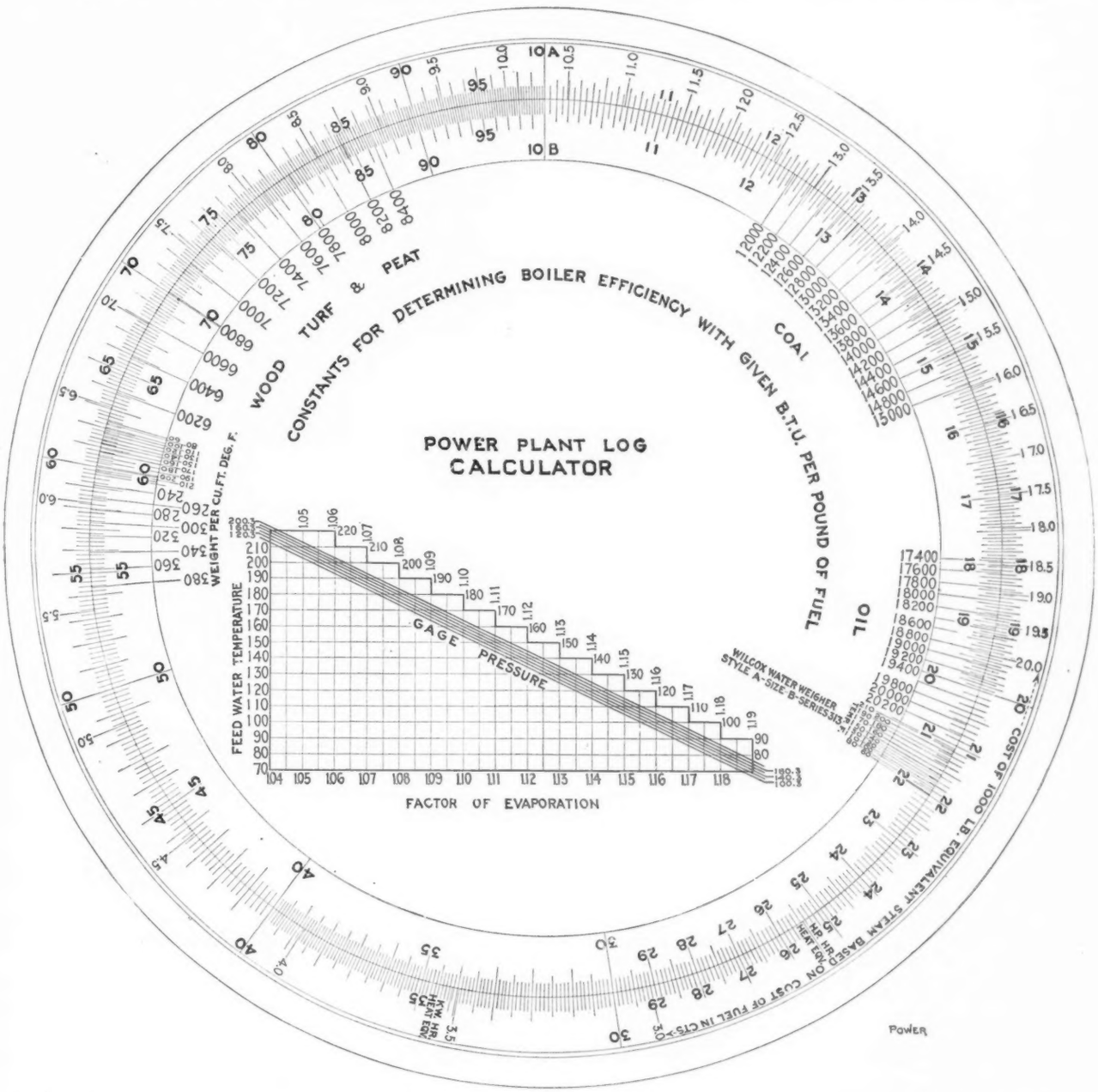
Equivalent Evaporation—Set 10B of the disk opposite the factor of evaporation number on the dial. The result appears on the dial opposite the actual evaporation number on the disk.

Efficiency of Boiler and Grate—Set the heat-value factor (British thermal units per pound of fuel) shown on the disk opposite 10A on the dial. The result appears on the dial opposite the equivalent evaporation number on the disk.

Cost of 1000 lb. of Equivalent Steam—Set the observed efficiency number on the disk opposite the cost of one million British thermal units in the shape of fuel shown on the outer scale of the dial (which is designated for calculation of cost, but does not show the cost). The result appears in cents on the dial opposite 10B.

Load Factor—Set the number of kilowatts in the peak power load on the disk opposite the number of average power read on the dial. The result appears on the dial opposite 10B.

Thermal Efficiency of the Whole Plant—Set 10B of the disk opposite the constant for kilowatts or horsepower printed on dial. Note the point on the dial opposite the output number on the disk. Set the disk's figure of pounds of fuel consumed under previously located point on dial opposite 10B. Set again the disk so that opposite the point thus found will be the number of British thermal units per pound of fuel used. Do not use constants for the determination of boiler efficiency. The result appears on the dial opposite the 10B mark.


POWER PLANT LOG
CALCULATOR
CONSTANTS FOR DETERMINING BOILER EFFICIENCY WITH GIVEN B.T.U. PER POUND OF FUEL
WOOD TURF & PEAT
COAL
OIL
GAGE PRESSURE
FEED WATER TEMPERATURE
FACTOR OF EVAPORATION
WEIGHT PER CU.FT. DEG. F.
WILCOX WATER WEIGHER
STYLE A-SIZE B-SERIES 313
COST OF 1000 LB. EQUIVALENT STEAM BASED ON COST OF FUEL IN CTS.
POWER

Use as Slide Rule—Any multiplication can be made following the rule for determination of equivalent evaporation and division by following the rule for load factor. All these calculations and others not mentioned can be made quickly and accurately with the calculator.

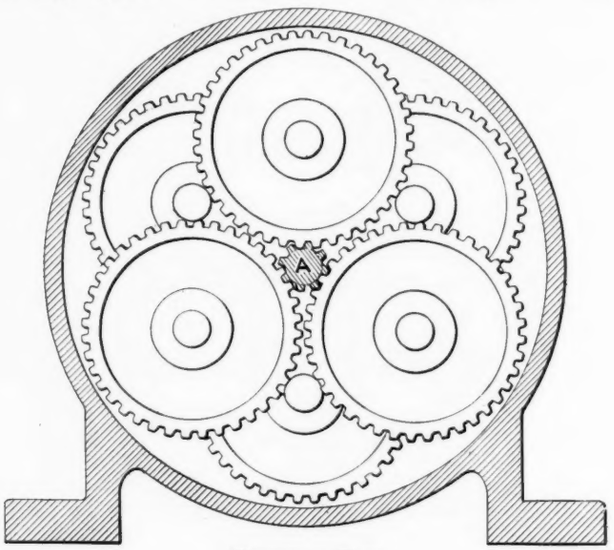
Novel Reducing Gear

To avoid the excessive stress set up in the teeth of single-reduction gearing and to balance the thrust on the driving and driven shafts, C. H. Clark, of New York City, has invented the reducing gear illustrated herewith. It is adapted for making a large change in the rotative speed where considerable amounts of power are involved.

The pinion *A* on the power shaft is surrounded by six gears arranged in two planes in sets of three and spaced 60 deg. apart. A shaft from each of the gears carries a pinion on the opposite end and these six pinions mesh with a gear wheel on the driven shaft.

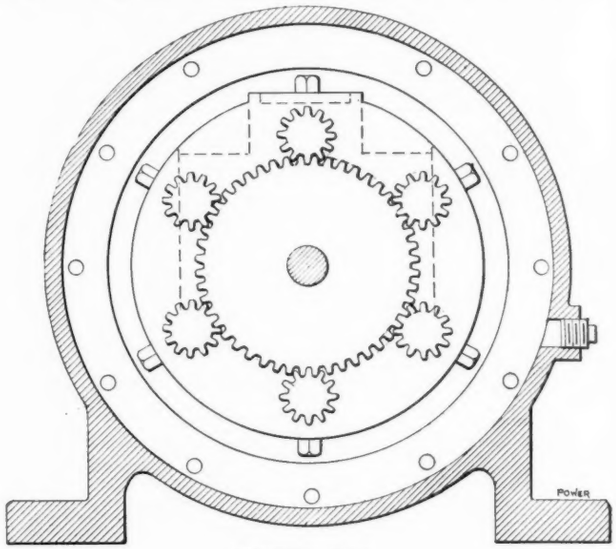
Due to the six contacts the same pinion on the power shaft might safely transmit six times the power, or in transmitting the same power its size may be materially reduced. This reduction in the size of the primary pinion will permit lower surface speeds, and reducing gears of small diameter.

The comparative proportions of a single reduction of 20 to 1 and the Clark system for the same reduction is shown in Fig. 2. Add to a compact mechanism the elimination of side thrust, and the advantages may overbalance the complication of the device.



DRIVING END

FIG. 1



DRIVEN END

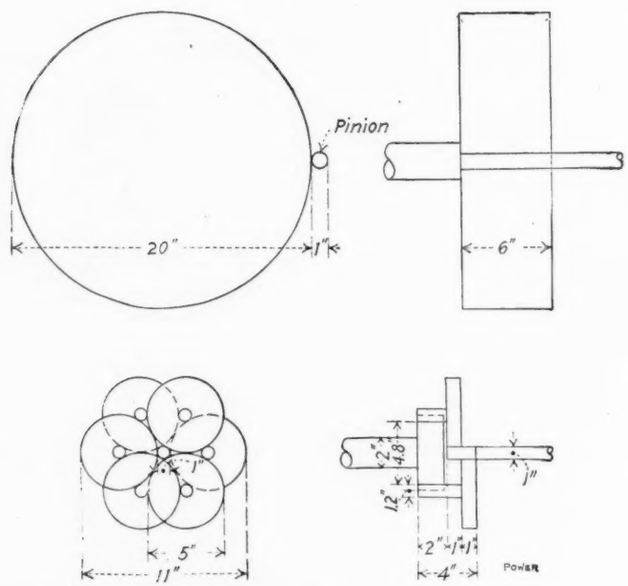


FIG. 2. COMPARATIVE SIZE OF 20-TO-1 SINGLE-REDUCTION GEAR AND CLARK SYSTEM

❋

The Geared Turbine

In a paper read by C. W. Cairns before the Northeast Coast Institution of Engineers and Shipbuilders, states *Engineering,* the author gave the results of a carefully conducted comparative trial of the "Cairngowan" and the "Cairnross," the former being fitted with reciprocating engines and the other with geared turbines.

Both boats were 370 ft. long, 51 ft. beam, had approximately the same lines and displaced about 10,000 tons. The boiler equipment in each consists of three single-ended boilers, 14.9x10.6 ft., having a working pressure of 186 lb. The "Cairngowan's" engine cylinders were 24, 40 and 66 in. in diameter by 45-in. stroke, and on a 36-hr. test developed an average of 1790 i.hp. The "Cairnross" had a high- and low-pressure turbine geared to a single main shaft, the reduction ratio being 1 to 26.2, developing on the test 1570 shaft horsepower. The propeller speed of each was approximately the same, or 61.7 r.p.m.

These boats were sent side by side over the same course during the 36 hours' trial, and the instructions were to keep in sight of each other during the run. The "Cairnross" consumed 22,000 lb. of coal, the "Cairngowan" 22,700 lb.

Actually, the turbined boat had a very considerable reserve of power, since the pressure at the turbine stop valve was 158 lb. only, as against 175 lb., which was the corresponding figure for the reciprocating engine, and lighter boilers could have accordingly been used for the "Cairnross" without reducing its effective power below that of the "Cairngowan." As special attention was paid to having the hulls of the two ships in a similar state of cleanliness, the results of these very important and interesting trials may be taken as conclusive evidence of the greater efficiency of the geared turbine as compared with good triple-expansion engines.

ELECTRICAL DEPARTMENT

Primer of Electricity

By Cecil P. Poole

Dynamo and Motor Armature Windings

There are two general classes of armature windings: Drum and ring. The names are due to the forms of the cores on which the windings were at first used; the core of a drum armature consisted of thin disks of soft iron mounted directly on the shaft, as in Fig. 152, and the core of a ring armature was (and still is) annular, as represented in Fig. 153. Drum armatures in bipolar machines are still of the type illustrated in Fig. 152, but in multipolar machines they are annular. The chief difference between a ring armature and a multipolar drum armature is in the arrangement of the winding; the windings of all ring armatures encircle the single cross-section of the ring, as represented in Fig. 154, whereas all drum windings embrace the entire core, regardless of its form, as illustrated elementarily in Fig. 155, which represents a coil of four turns on a smooth drum core.

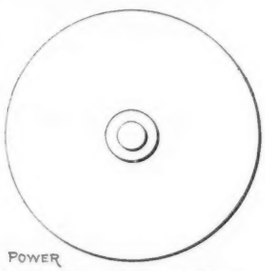


Fig. 152. Drum Core

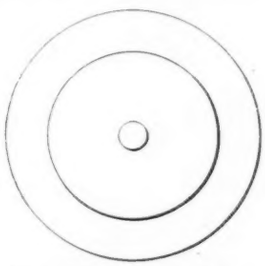


Fig. 153. Ring Core

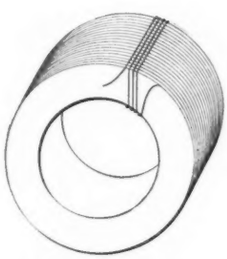


Fig. 154. One Coil of a Ring Winding

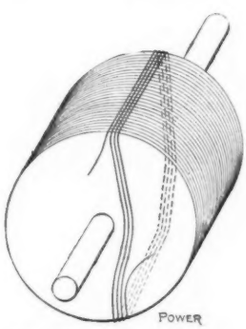


Fig. 155. One Coil of a Drum Winding

Ring armatures have gone out of use in this country, except in a few makes of high-potential constant-current dynamos and some small motors. The winding of this type is connected to the commutator as indicated in Fig. 156, which represents a winding of 16 coils, each containing only one "turn" around the core cross-section. The arrow-heads show the direction of the current and the arrow *R* indicates the direction of rotation necessary to cause the armature current to flow as represented. When the commutator bars connected to any coil pass either of the brushes (when in the position shown), the direction of the current through that coil reverses. For example, when the armature has moved one-sixteenth of a revolution, the coil *A* will be where the coil *B* is and the current will flow through it in the direction of the arrow-head on the coil *B*.

Fig. 157 is a diagram of a drum winding which is the equivalent of the ring winding in Fig. 156. As in that case, each coil consists of a single "turn" or loop, but embracing the entire core instead of one-half of it. There are only 8 commutator divisions or bars, however, and 8 armature coils, as compared with 16 in the other diagram. The reason for this is that in a drum winding each "turn" of a coil includes two stretches of wire along the outer face of the armature core, whereas each turn of a ring winding includes only one wire lying along the face of the core; therefore, for the same number of active wires disposed around the circumference of the core, and the same number of turns per coil, a drum winding requires only one-half the number of coils contained in an equivalent ring winding.

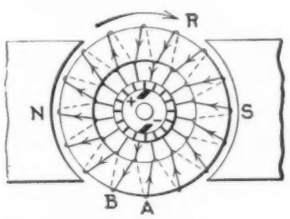


Fig. 156. Ring Winding

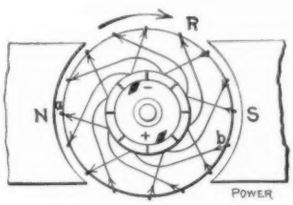


Fig. 157. Drum Winding

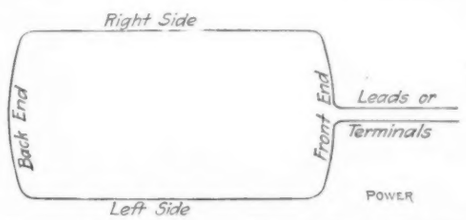


Fig. 158. Names of Drum-Coil Parts

The ring winding has three serious disadvantages in construction as compared with the drum type: (1) The coils cannot be wound and insulated individually without making the core in two or more separable sections, which has been tried out thoroughly and found impractical; (2) it is difficult to mount the armature accurately and securely on the shaft, because the core is entirely covered by the winding; (3) the labor of winding is expensive, because the wire must be threaded through the central opening of the core for every turn in the winding. There is also the disadvantage of sparking at the brushes in machines built to deliver heavy armature currents, under existing conditions of practice in design; but this would probably be remedied if the mechanical construction were sufficiently "workable" to justify the ring type.

The drum type of armature embodies the disadvantage of overlapping coils at both ends of the core. This makes it impossible to repair a damaged coil without disturbing

several others and also makes it necessary to take special precautions in insulating the overlapping portions, to prevent crosses between adjacent coil ends.

Fig. 158 is a reference diagram indicating the names of the different parts of a coil; these names apply to all coils for drum windings, no matter what their form or type. The "sides" of the coil are the straight portions which lie parallel with the armature shaft and in which the electromotive force is generated; the "ends" serve merely as conductors from one "side" of the coil to the other.

The principle on which all modern drum windings are constructed is that the two sides of each coil must pass through magnetic fields of opposite polarities at practically the same time. Fig. 159 illustrates this condition

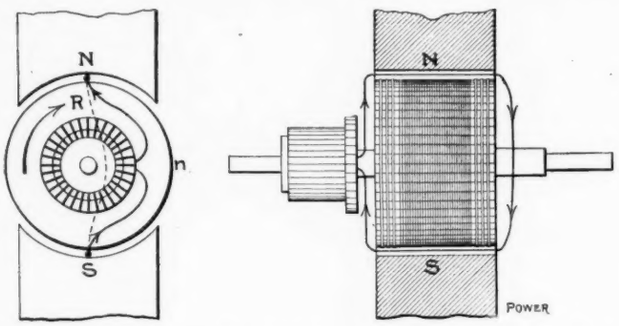


FIG. 159. RELATIVE LOCATIONS OF THE SIDES OF A COIL, BIPOLAR WINDING

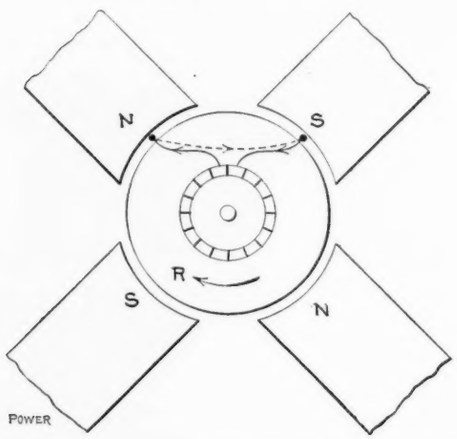


FIG. 160. FOUR-POLE DIAGRAM CORRESPONDING TO FIG. 159

for a bipolar machine and Fig. 160 is the corresponding diagram for a four-pole machine; in both figures the arrow *R* shows the direction of rotation and the arrow-heads indicate the direction of current flow in the wires. It is obvious that when one side of the coil (Fig. 159) moves from left to right under a north pole, the other side moves from right to left over a south pole; consequently, the electromotive forces induced in the two sides of the coil by the north and south magnetic fluxes assist each other in forcing current through the coil. Note that motion by a conductor from left to right *under* a magnet pole induces electromotive force in the same direction as motion from right to left *over* that same pole or one of the same polarity.

If one side of the coil in Fig. 159 were located at *n*, 90 deg. distant from the other side, it would be idle while the other side was active, and the coil would generate only one-half the normal electromotive force. If the coil in Fig. 160 were placed on the core with its sides at opposite diameters instead of at points 90 deg. apart, the electromotive forces induced in the two sides of the coil would oppose each other and, as a result, no current would flow.

In large machines, the armature coils usually consist of one turn each, forming a simple loop. In most other machines, each armature coil contains several turns of wire. Fig. 161 represents a one-turn "lap-winding" coil, Fig. 162 a one-turn "wave-winding" coil and Fig. 163 a "wave-winding" coil of three turns. The terms "lap-winding" and "wave-winding" refer to the manner of connecting the coils to the commutator; there is no essential difference between the coils themselves except in the disposition of the terminals where they lead out from the coil.

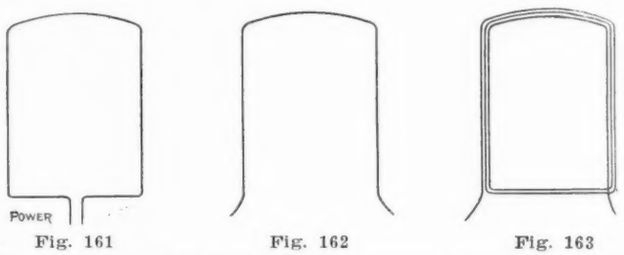


Fig. 161 Fig. 162 Fig. 163

FIG. 161. A ONE-TURN LAP-WINDING COIL. FIG. 162. A ONE-TURN WAVE-WINDING COIL. FIG. 163. A THREE-TURN WAVE-WINDING COIL

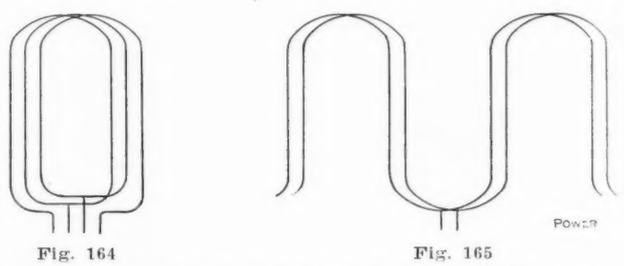


Fig. 164 Fig. 165

FIG. 164. THREE ONE-TURN LAP-CONNECTED COILS LAID OUR FLAT. FIG. 165. FOUR ONE-TURN WAVE-CONNECTED COILS LAID OUT FLAT

The terminals of a lap-winding coil are brought out as close together as practicable and those of a wave-winding coil are brought out as far apart as practicable. The reason for this is that the leads of the lap-winding coil are connected to commutator bars which are close together—usually next to each other—and those of the wave-winding coil are connected to bars which are separated by a distance greater than that between the two sides of the coil.

The lap winding, or, more accurately, "lap-connected" winding, is so named because successive coils lap backward, forming a series of overlapping loops, as represented diagrammatically in Fig. 164. This is a schematic diagram of three one-turn coils of a lap-connected winding as they would appear if taken off the armature core and laid out on a flat surface without disturbing their relative positions. The wave-connected winding progresses continuously around the core, as indicated diagrammatically in Fig. 165, which represents two neighboring pairs of one-turn coils laid out flat.

Light and Power at Panama-Pacific Exposition

A contract for supplying all the electricity, gas and steam to be used by the Panama-Pacific Exposition has been made with the Pacific Gas & Electric Co., of San Francisco. This represents a deal of considerably more than a million dollars, and is the largest that has yet been entered into by the exposition company. It provides for a minimum of 12,000 hp. during the period of construction, which has already commenced, and 20,000 hp. during the actual life of the exposition, which will last from Feb. 20 to Dec. 4, 1915.

An immense generating plant is to be erected on the exposition site on a lot which formerly belonged to the old San Francisco Gas Co., but which has been leased to the exposition authorities free of charge. The plant will serve a dual purpose: Besides generating the power for the fair, it will also serve as the Pacific Gas & Electric Co.'s special exhibit and visitors to the exposition will be shown every process in the preparation of the light, heat, power and illumination which will be used in the greatest exposition in history.

The steam supplied is to be used mainly for heating purposes, and the exposition company, according to the contract, agrees to use 30,000 lb. per hr. between 10 a.m. and 5 p.m. each day during the life of the exposition The streets, which will cover an area of 625 acres, will be lighted chiefly by gas; the wonderful decorative illuminations being effected by electricity.

After the exposition the generating plant will be used by the Pacific Gas & Electric Co. as a substation for supplying individual consumers.

The Pacific Gas & Electric Co. already possesses eleven power houses with a total installed capacity of 96,000 hp., and a new hydro-electric plant which it is building on the Bear River will add 53,300 hp. capacity, apart from the additional capacity in the exposition substation.

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Most Powerful Electric Locomotives

The New York Central is to put in service on the New York Terminal division, ten new electric locomotives which will be the most powerful of their kind in existence. Although weighing only 100 tons, which is 15 tons less than those now in service, they will be more powerful, as the whole weight is carried on the drivers. Normally they will develop 1400 hp. continuously and will be capable of developing as high as 5000 hp. for short periods. They will exert sufficient tractive effort to haul a train weighing 1000 tons at 60 miles per hour.

Each locomotive has eight bipolar motors having the armatures mounted directly on the axles and the field poles carried on the truck frames. The motors are connected permanently in pairs and can be run in three combinations: Series, series-parallel and parallel. Although they will be operated at 600 volts, they are insulated for 1200 volts so that, if at any future time it should be desired to operate at 1200 volts, the pairs of motors could be changed from parallel to series with the same speeds and control combination as at 600 volts.

One of these locomotives has already been thoroughly tested out on the Harlem division, and the General Electric Co. is now filling the order for the remaining nine.

CORRESPONDENCE

Increasing Exciting Current

Permit me to add to the reply to E. J. R., in POWER of Mar. 18, regarding the effect of increasing exciting current on an alternating-current generator. It has been my experience that those operating alternators in parallel often fail to understand the effects of varying the exciting currents on the machines and on that account fail to secure the best distribution of load. Take the case of two machines in parallel with the voltage controlled by an automatic regulator acting on one machine only. In this case the other machine may be made to take a leading or lagging current at will by varying the exciting current, provided, of course, the exciter has the required range. As the power factor of the system is fixed by the character of the load, if the power factor of one machine is raised or lowered that of the other machine moves in the opposite direction.

To illustrate: With a given load and power factor a certain number of amperes must be supplied to the line. If two or more machines of equal capacity are supplying current to the line each should supply the same current, but that supplied by one of the machines can be varied by varying the exciting current on that machine. As a general rule, where two or more machines are supplying current to a line, each machine should carry its share of the wattless current; hence the power factors should be the same on each machine and the operators should see that the ratio of amperes to kilowatts is the same if power-factor meters are not supplied. The number of amperes will be the same only when the load in kilowatts is the same.

In practice many problems arise depending on the types of the generators and prime movers and character of loads. In some instances it will be found that a machine can carry its share of the line load, but is unable to carry its share of the wattless current. In other cases a machine may be unable to carry its share of the line load, but may be able to carry more than its share of the wattless current. Operators should bear in mind that it is the current in amperes that determines the safe load on a generator. If a machine is overheated it may be found to be carrying too much wattless current. In such a case if the exciting current is reduced the machine will still carry the same kilowatts but with less heating. It is, therefore, important that an operator understand that the wattless current may be shifted from one machine to another, though, as stated in the reply to E. J. R., the power factor of the current on the line is determined by the character of the load and cannot be controlled by the generators.

G. E. MILES.

La Jara, Colo.

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A list of testing laboratories is to be compiled by the new Austrian government "Technische Versuchsamt" (Michelbeuerngasse 6, Vienna), says "Engineering News." Private and public testing laboratories throughout the world are asked to send the "Versuchsamt" all pertinent information concerning their field of work, organization, commercial or educational affiliation, equipment, and extent of operations.

GAS POWER DEPARTMENT

Humphrey Pumps for London Water-Works

Special interest centers about the new pumping station of the Metropolitan Water Board near Chingford, Eng., in that the equipment consists entirely of Humphrey gas pumps. Excepting a small plant at Dudley Port, this is the first commercial application of this type.

As London will depend to a large extent upon this installation for its water supply, the action of the water board's engineers in adopting a new type of prime mover may be considered bold. However, it appears that the subject was first gone into very carefully and several methods of pumping were considered.

The low head, 30 ft., and the large amount of water to be handled did not seem to warrant the expense of large reciprocating pumps. On the other hand, the efficiency of centrifugal pumps for this service figured some-

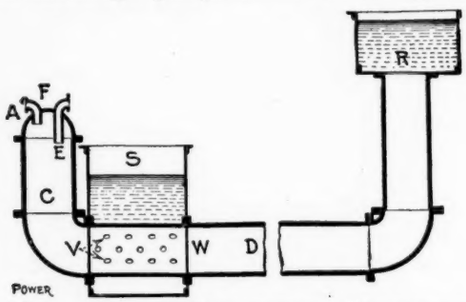


FIG. 1. ILLUSTRATING ELEMENTARY HUMPHREY PUMP

what less than the Humphrey pump. Moreover, it was found that the equipment, consisting of gas producers and Humphrey pumps, could be installed for about $90,000 less than steam boilers and triple-expansion engines driving centrifugal pumps, and that the fuel consumption would be less. The guaranteed fuel consumption with the Humphrey pumps was 1.1 lb. of coal per delivered horsepower-hour, and a penalty of $50,000 was provided for every 0.1 lb. in excess of this. It was further stipulated that should the outfit prove a failure, the sum of $100,000 should be forfeited by the makers of the pump.

The installation consists of four large pumps, each of 40 million gallons capacity, corresponding to approximately 250 hp. against a 30-ft. head, and a fifth unit of half this size. Each has an overload capacity of 25 per cent. The larger pumps are 7 ft. in diameter and the smaller one 5 ft.

The operation of the Humphrey pump was described in POWER over two years ago, but for the benefit of those readers who are not familiar with its operation we will quote from the Dec. 13, 1910, issue:

Take the simplest case of Humphrey pump, as illustrated in Fig. 1. Water has to be raised from a supply tank S to an elevated tank R. The water-valve chamber W is equipped with valves V, opening inward. In the top of the combustion chamber C is an inlet valve A and an exhaust valve E. A simple interlocking gear is arranged between these two valves, so that when the valve A opens and closes it locks itself shut and releases the valve E, and when the valve E opens and closes it locks itself shut and releases the valve A. Consequently, when suction occurs in the chamber these valves open in turn.

Imagine a charge of gas and air to be compressed in the top of the chamber C, and fired by a spark plug which projects through the top casting. All the valves are shut when the explosion occurs, and the increase in pressure drives

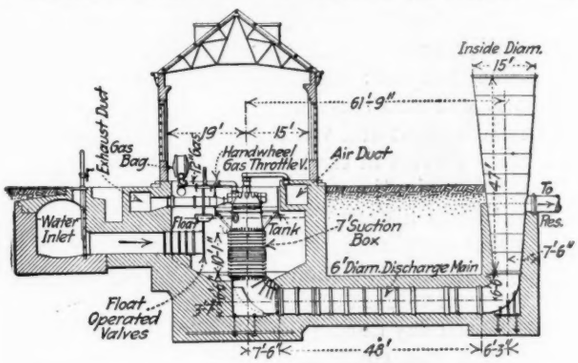


FIG. 2. SECTION THROUGH PUMPING STATION

the water downward in the pump and sets the whole column of water in the discharge pipe D in motion. The column of water attains kinetic energy while work is being done upon it by the expanding gases, so that when these gases reach atmospheric pressure the column of water may be moving with considerable velocity. The motion of this column of water cannot be suddenly arrested, hence the pressure in C falls below that of the atmosphere, the exhaust valve E opens and also the water valves V. Water rushes in through the water valves, mostly to follow the moving column in pipe D, but partly to rise in the chamber C in an effort to reach the same level inside the chamber as exists in the suction tank.

When the kinetic energy of the moving column has expended itself by forcing water into the elevated tank, it comes to rest, and there being nothing to prevent a return flow, the column starts to move back toward the pump and

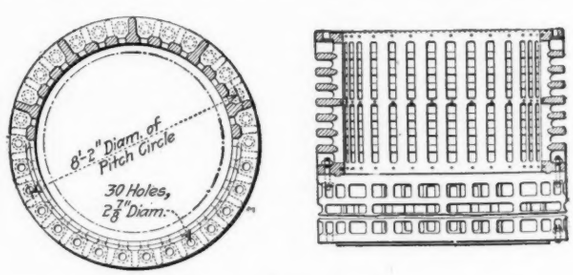


FIG. 3. SUCTION BOX

gains velocity until the water reaches the level of the exhaust valve, which it shuts by impact.

A certain quantity of burnt products is now imprisoned in the cushion space F, and the energy of the moving column is expended in compressing this gas cushion to a greater pressure than that due to the static head of the water in the tank R. Hence, a second outward movement of the column results, and when the water reaches the level of the valve E, the pressure in space F is again atmospheric, and further movement of the water opens the valve A against a light spring and draws in a fresh charge of gas and air. If there were no friction the water would fall to the same level as that from which the last upward motion started, but the amount of combustible charge drawn in is slightly less

*Compiled in part from London "Engineering" and the "Engineer."

than this movement would represent. Once more the column of water returns under the elevated tank pressure and compresses the charge of gas and air, which is then ignited to start a fresh cycle of operations.

Referring now to the present installation, Fig. 2 represents a section through the pump house, showing one of the units and its corresponding water tower; the object of the tower being to take up the surges and maintain a practically continuous flow through the 4-ft. pipe to the reservoir. The water intake is shown at the left leading to the water-admission valves, which are located in a

Considering the sectional view at the top of Fig. 5, the scavenging valve takes its air supply from a central chamber, connected with the air duct, and the fuel inlet is provided with a check and mixing valve and also a supplementary air valve. All the valves are spring operated and open inward. Catches and levers are provided for interlocking the fuel inlet and scavenging valves so that they cannot open together. These also connect through rods (see Fig. 4) to the exhaust valves. The latter, unlike the other valves, are kept open by the springs, but

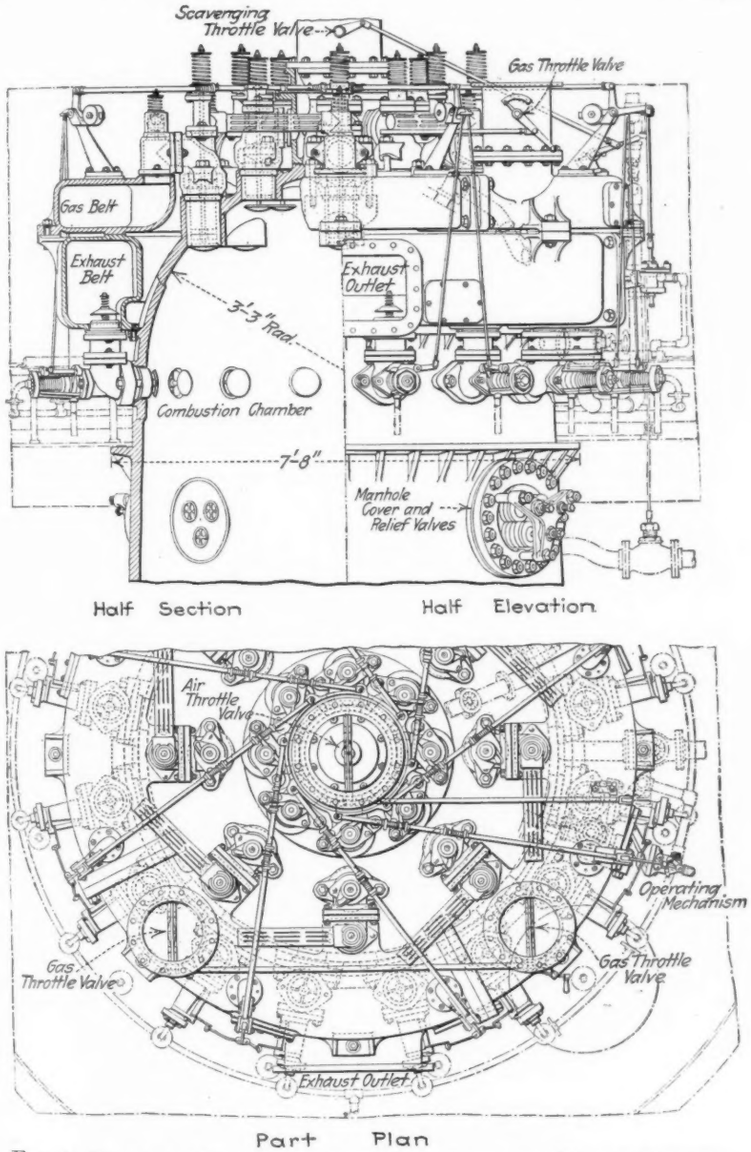


Fig. 4. Plan and Elevation of Pump, Showing Valve Control

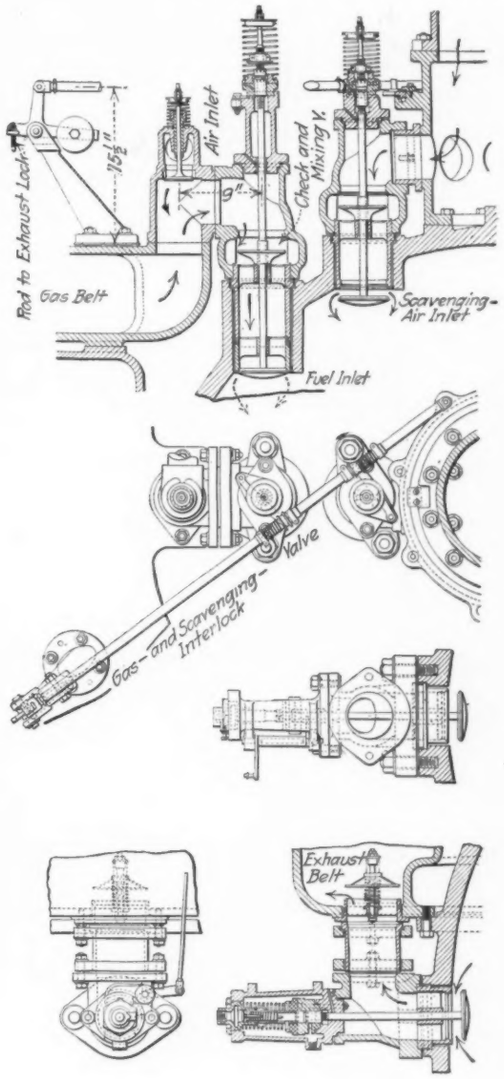


Fig. 5. Details of Valves

ring casting or suction box at the base of the combustion chamber. This is shown in detail in Fig. 3.

The air is supplied to the combustion chamber through an air duct located under the floor (Fig. 2). A blower is provided for supplying this air under pressure for scavenging when operating at an overload, but as yet it has not been found necessary to use this blower. As the pumps exhaust at nearly atmospheric pressure, their operation is practically noiseless.

Fig. 4 shows a plan and elevation of the combustion chamber with its numerous valves, and Fig. 5 shows these valves in detail.

are latched shut during the suction strokes. There are eight sets of fuel and scavenging valves and sixteen exhaust valves per unit, and the rods all lead to a central ring, which permits moving all simultaneously.

On the first (explosion) stroke all the valves are closed until the suction becomes great enough to open the scavenging air valve. On the second (return) stroke the exhaust valves must be open to permit expulsion of the bulk of the exhaust gases. On the third stroke the scavenging valves must be kept closed and the fuel valves must be free to open automatically. All the valves must be closed on the fourth, or compression stroke. This

locking is effected by means of an operating cylinder and oscillating piston connected with the combustion chamber.

The exhaust valves are provided with dashpots to prevent chattering.

Ignition is of the make-and-break type supplied by storage batteries and is actuated by a piston raised by the water pressure during the compression stroke.

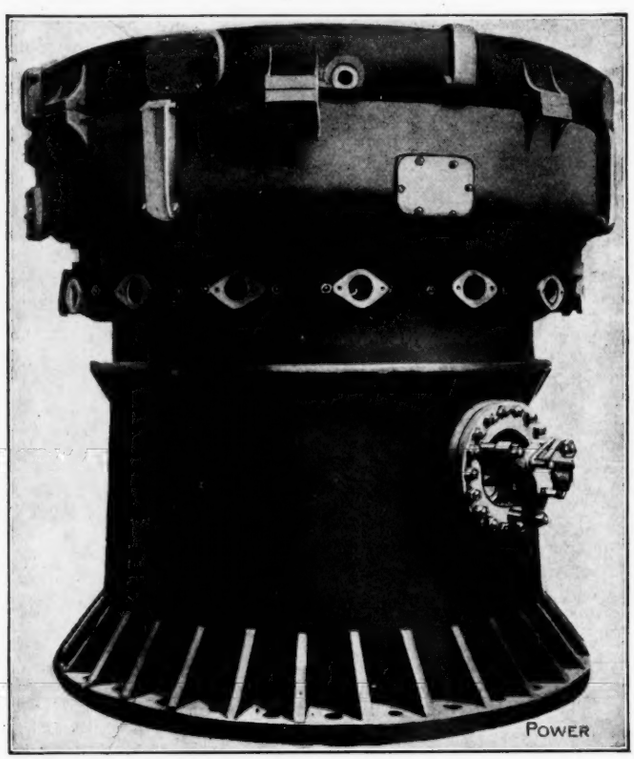


FIG. 6. COMBUSTION CHAMBER OF HUMPHREY PUMP BEFORE INSERTING VALVES

The gas is supplied by four Dawson anthracite producers located in an adjacent building. From the producers the gas first passes to a coke and sawdust scrubber, thence to the holder, and finally through large cylindrical gas bags to the pumps.

Record of a Suction Gas-Producer Plant

BY GEORGE W. MUENCH

Engineers are always glad to get actual records of gas-power plants that have been in operation for some time, to ascertain what success their fellow operators are having. The following relates to a plant located in Seattle, Wash. This gas plant was put into service, May 10, 1911, and was operated continuously until November, 1912, the fire in the producer never having gone out nor been drawn during that period. The plant was shut down at the latter date for reasons entirely foreign to its operation and which are not necessary to mention here; it suffices to say that the plant gave complete satisfaction.

The producer was built by the Schmidt Gas Power Co., of Olympia, Wash., and is of 100 hp. capacity, furnishing gas for two engines. Although classed as an updraft producer its construction is such as to make it practically a combination up and down draft. The gas outlet consists of a large water-cooled tube passing down through the top of the producer and through the fuel to within 2 to 2.5 ft. of the grate, so that all the gas above the lower end of the tube has to pass through the hot fuel on its way to the engine; this makes it really a double-zone producer. The grate is in three sections; each section can be rocked independently of the others, and the entire grate can be rocked as a whole. This makes it possible to remove the ashes in a comparatively short time.

The washing apparatus consists of a centrifugal scrubber only, no tower scrubber nor dry scrubber being employed. The centrifugal scrubber when running at 1100 to 1200 r.p.m. washes the gas satisfactorily. A motor for running the washer, and a small tank to catch the waste water and tar completes the producer equipment, except, of course, the coal-handling apparatus.

Both engines are of the two-cylinder vertical type, one a 50-hp. Fairbanks, Morse, and the other a 28-hp. Nash. The former was belted to an ammonia compressor and the latter to a generator. The Fairbanks, Morse engine ran continuously 24 hr. per day, from May 11, 1911, to Dec. 1, 1911, and from March, 1912, to Oct. 1, 1912; the Nash ran only from 8 to 10 hr. per day and did not run every day. The former had to carry an overload almost all the time, while the latter often carried as much as 38 hp. for an hour or two at a time. The chief source of trouble during the entire run was the overloads on the engines, there being no relay power and, therefore, no time for overhauling.

The Fairbanks, Morse engine was equipped with a Detroit forced-feed lubricator and filtered oil was used with this, even for the cylinders. The Nash engine having splash and forced lubrication, the oil was not drawn from the crank case until it was too dirty for filtering, when the crank case was refilled with new oil. By this it is not meant that the oil was allowed to get decidedly foul, but at the same time, it was hardly worth filtering. The oil consumption was about 50 to 60 gal. per month, including that used for all the motors and other machines, except the compressor.

Waste water from the ammonia condenser was used for jacket cooling, and connections were so made that city water could be used directly when necessary. Occasionally city water was turned into the jackets to clean them thoroughly, as the water from the condenser pan was rather dirty. Only once was trouble encountered, and that was clogging, due to floating matter in the condenser water, rather than actual scale formation. The Nash engine jacket-water temperature was kept at 150 to 160 deg. F. and that in the Fairbanks, Morse engine from 120 to 140 deg.

The fuel was cheap lignite costing $2.10 per ton (pea size) f.o.b. at the plant, including unloading, and nut size costing $2.85 in the bin. We used both, and part of the time mixed pea and nut. In two instances, owing to delay of shipment, we were forced to use lump size pounded small enough to pass through the producer hopper. This did not give as good satisfaction as either the pea or nut, and required more frequent and harder working of the producer; it also gave more clinker trouble. There was little difference between using the pea and the nut coal expect that it was necessary to use a little more of the former. However, it was easier to handle and

made the producer easier to work. Very accurate records were kept of the fuel consumption. The best month showed a consumption of 1.75 lb. of coal per b.hp.-hr., although the average consumption was about 2.5 lb. per b.hp.-hr. The fact that the night load was only about 55 per cent. of the rated capacity of the producer had a tendency to keep the fuel consumption high.

The lignite used contained from 12 to 20 per cent. moisture and occasionally even more, and it averaged about 15 per cent. ash. The heat value ranged from 7000 to 9000 B.t.u. per lb. as fired, but seldom as high as 9000.

When the gas plant was first started the producer was worked every 6 hr. and sometimes oftener. Later, however, it was worked at 8-hr. intervals, except occasionally the fire zone became too deep and then it required a little extra attention. Also now and then the fire would require a little poking from the top to check the formation of clinkers.

Each working consisted of poking the fire and breaking the clinkers from the top as much as possible, removal of the ashes and charging the producer. The entire process of poking, removal of clinkers and removal of ashes from the grate and ashpit usually took from 25 to 60 min. when everything was in good condition. Only one man was required to take care of the engines and producer, and on the night shift he also took care of the entire plant, including boiler, ice plant, etc.

Except for occasional clinkering, due to bad coal or insufficient steam, the producer gave very little trouble. In the winter, when the plant was shut down each evening, a little air was allowed to pass through the producer, then the next morning it would require only 10 to 15 min. to get the engine started and the load on. We first tried shutting off the air entirely, but found it would take from 30 to 45 min. in the morning to blow the fire sufficiently to get gas rich enough for the engine.

Steam for the producer was obtained from a 40-hp. boiler, which was also used for heating hot water, etc.; this was entirely independent of the power plant. A ¼-in. pipe line under 30-lb. steam pressure led to the producer, but the valve at the boiler was never opened more than half a turn.

For blowing the fire, the tar extractor was used. This drew air through the producer and purged the gas through a special starting purge pipe located just above the tar extractor. The motor driving the tar extractor was driven by city power when the Nash engine was not running.

Most of the engine troubles were of a minor nature. Occasional difficulty was experienced in starting the Fairbanks, Morse engine, because it had to be started with some load, it having no clutch to throw out the ammonia compressor. This was bypassed when starting, but, nevertheless, there was always some load to start against. Another thing that required careful attention was that when the engines were overloaded, they were sensitive to slight changes in the quality of the gas so that it was necessary in working the producer to keep the gas from getting too weak. When either of the engines showed signs of slowing down we would stop working the producer for 5 or 10 min., and when the engines picked up, would finish working the producer.

Usually lignite producer plants have considerable trouble from tar. When first starting the plant we did not have the tar extractor running fast enough, hence, encountered some trouble with the valve stems sticking and the valves chattering. The chief trouble was with the intake-valve stems on the Nash engine. After shutting this engine down in the evening, unless we worked the valves up and down and lubricated them freely with kerosene and oil, they would be found stuck the next morning and hard to loosen. After speeding up the tar extractor several hundred revolutions we had no more trouble.

Daily reports were made, accurate records being kept of the consumption of fuel, lubricating oils, kerosene, gasoline, waste and city water. Load readings were taken every two hours. The stops of each engine were recorded as was also the cause of each stop. At the end of each month a monthly record sheet was filed which showed the consumption of fuel, oils, supplies and the coal used per brake horsepower-hour. Besides actual cost of operation these reports aided in locating troubles and also gave the engineers special interest in the work, as they always were working for a record month.

The record of this plant brings out several points of special interest. First of all, the Fairbanks, Morse engine carried an overload of about 25 per cent. almost continuously during its two runs of seven months each, with no opportunity for overhauling except during the winter. Another point worth noting is that the Nash engine occasionally carried a 40 per cent. overload for about 2.5 hr. The producer responded to all variations in load, and in spite of several exceptionally poor shipments of coal, it was never necessary to draw the fire during the entire run. When the plant was shut down and the fire drawn the brick lining in the producer was found to be in very good condition.

Removing Piston Rings

Mr. A. L. Brennan, Jr.'s method of removing and cleaning piston rings, which appeared in the Apr. 8 issue, would not do if he were in a plant that could not spare an engine very long. He speaks of removing carbon deposits with strips of emery cloth. Upon removing rings, I have found deposits of carbon in the grooves ⅛ in. thick that required a cape chisel and hammer to dig out. Kerosene is all right for softening carbon if the part can be soaked long enough, but in a power plant time is usually important.

With reference to replacing the rings, he says it is advisable to place the top ring first and so on down, but I have found it to be easier first to put on the rings with the liners or strips to carry the ring to the groove.

J. W. Fries.

Ft. Wayne, Ind.

There is a tiny hamlet in southern Alaska, called by the natives Katalla, boasting of a few hundred inhabitants, which really knows what the high price of coal means. Each and every ton burned in that town costs exactly $21.75. And within 25 miles is one of the richest coal deposits in the world. It is the famous coal region about which the Pinchot - Ballinger - Cunningham - Guggenheim controversy was waged. The Federal government now controls those deposits, and the inhabitants of Katalla are prevented, through this control, from mining their fuel needs, which total only 60 tons annually, and are forced to depend upon fuel mined many hundreds of miles away.—"Wall St. Journal."

HEATING AND VENTILATION

District Heating by Steam and Hot Water

By L. B. Lent

The advantages of heating one or several blocks of residences or business buildings from a central heating station are fairly well known. It is obvious that even where supplying heat is the only consideration a higher degree of economy in its generation at least could be attained in a large central plant where coal could be burned under economical conditions, where the labor required is reduced to a minimum, and where economical operation in general can best be had. The principal disadvantage of district heating is that it requires in most cases an extensive and costly system of piping and conduits, and in some cases also requires the purchase of a franchise for laying conduits in the streets or public highways.

When heat is furnished to a group of buildings from a central station in which a considerable amount of power is also generated, the two duties may then be profitably combined. Especially is this true of a central lighting and pumping station. In a power plant using steam as the motive power, where condensing water is costly, it is even possible to make the heating end of the power plant a condensing system for the steam engines and other steam apparatus.

To make an accurate calculation of the amount of heat necessary to supply a given amount of radiation already installed, or that which is to be installed, the compilation of the individual requirements of each customer must be made, but this amount may be estimated with a fair degree of accuracy by estimating the cubical contents of the buildings to be heated and allowing about one square foot of radiation for each 70 cu.ft. of volume.

The consideration which governs a choice between steam and hot water may be stated as follows: The first cost of the plant installed is in favor of the steam system, when it is not equipped with heat control. The cost of operation is usually in favor of the hot-water system, if heat is supplied from the exhaust of steam apparatus and especially if in heating the water with exhaust steam more or less of the steam may be condensed and the engine run under partial vacuum. The cost of circulating mains is in favor of hot water when forced circulation is employed, and besides the steam temperatures are usually higher, so that radiation losses will be greater than for hot water. Where the area supplied is comparatively large and exhaust heat from the engines is available, a consideration of all features indicates that hot-water circulation will be preferable.

Steam System

The sources of heat for the steam system are exhaust steam from engines, pumps or other steam apparatus, and live steam from boilers. While steam heat is classified under two general heads, high pressure and low pressure, it is common practice to reduce high-pressure steam to 30-lb. gage or less before introducing it into the line. Where exhaust steam is used direct, it is seldom good practice to run the pressure above 10-lb. gage, because of the reduced efficiency of the engines from this high back pressure. The amount used for heating purposes is the total heat of the steam above 32 deg. F. less the total heat in the condensation returned from the radiators. The temperature of the return condensation varies but is seldom less than 180 deg. F.

With exhaust steam it is necessary to ascertain the total heat of the steam under the conditions at which it is available. This may be done by assuming that it is equal to the total heat of steam entering the engine or pump cylinder, less the heat equivalent of the work done, and a further subtraction for radiation and condensation losses in the engine. An average value of the total heat in the exhaust steam may be safely assumed as 85 per cent. of the total heat of the live steam delivered to the engine. If the thermal efficiency of the engine is known the calculation of the available heat in the exhaust steam can be more accurately made. Of the total heat furnished by live steam or exhaust steam it is safe to assume that the transmission loss in the conduit will be about 15 per cent. and this leaves 85 per cent. of the total available heat which may be counted upon as producing heating effect in the radiating surface.

Radiating Surface per Pound of Steam

On the assumption that a room temperature of 70 deg. F. is to be maintained in zero weather, and that each square foot of radiating surface will radiate 1.7 B.t.u. per sq.ft. per deg. difference in temperature between the air and the steam for an average steam pressure of, say 5-lb. gage, about 267 B.t.u. per hr. per sq.ft. of radiating surface will be radiated, so that if the total radiating surface be multiplied by 267, the product will be the number of heat units to be supplied per hour. The inverse calculation shows that, allowing 15 per cent. heat loss in the conduit, exhaust steam at 5-lb. gage pressure which contains, say 900 B.t.u. per lb., will supply.

$$900 \div (267 \times 0.85) = 4\ sq.ft.$$

A similar calculation can easily be made for live steam by using the total heat available in place of the figure 900. It is evident that the amount of radiating surface supplied by the high-pressure steam is not greatly in excess of that supplied from exhaust steam, and if the steam supply necessary is estimated conservatively the figure of 4 sq.ft. of radiating surface per pound of steam per hour will not be far wrong.

Steam Pipe Sizes

The size of steam pipe for supplying a given quantity of steam under given conditions may be obtained by reference to the charts given in the article by H. V. Carpenter, Power, Dec. 17, 1912.

Knowing the square feet of radiation, an approximate rule for determining the diameter of main in inches to supply it is:

Divide the square feet of radiation by 100 and extract the square root of the quotient.

The rule is based on a velocity of 40 ft. per sec. in the main. For other velocities reference may be made to Table 1.

Hot Water Systems

In this system actual heating of the water may take place in exhaust-steam heaters, live-steam heaters, heating boilers, economizers and condensers. One of the most economical sources of heat is, of course, that of the exhaust steam from engines and other steam-consuming machines. The amount of this heat is as before shown about 85 per cent. of the total heat of the steam entering the engine and it is obvious that most economical operation from the standpoint of the engine is brought about when its exhaust steam is condensed by giving up its heat to the circulating water. The amount of vacuum produced is limited by the amount of heating water circulated and also by its temperature. If it is desired to circulate the water at a temperature of, say 180 deg. F., it is apparent from the steam table that at this temperature a vacuum of 14.4 in. of mercury can be carried. This will increase the economical performance of the engine considerably.

It is evident that a large amount of water must be circulated at this temperature, to condense the steam, especially as the circulating water is rarely cooled through a greater range than 20 deg. Since the latent heat of steam at this pressure is 990 B.t.u., there must roughly be circulated about 50 lb. of water per pound of steam, or an equivalent of slightly over 6 gal. of water per pound of steam.

It then becomes necessary to ascertain whether the total amount of water necessary to condense the exhaust steam can be cooled through the temperature range by circulating it through the radiating system. If it is assumed that each pound of water is raised in temperature 25 deg. F. in passing through the exhaust-steam heaters, the pounds of water that may be heated by one pound of exhaust steam will be the total heat available per pound of exhaust steam divided by 25, and if it is assumed that under average conditions the total heat available will be 850 B.t.u. per hr. per lb. of exhaust steam, then the number of pounds of water heated per pound of steam will be

$$850 \div 25 = 34$$

If it is assumed that the temperature drop of the water passing through the radiators is 20 deg., then this 34 lb. of water will give up

$$34 \times 20 = 680 \; B.t.u.$$

If the room temperature is 70 deg. and the water is cooled from 180 to 160 deg. F. (an average temperature of 170 deg.), then the difference in temperature will be

$$170 - 70 = 100 \; deg.$$

so that each square foot of radiating surface will radiate

$$100 \times 1.7 = 170 \; B.t.u.$$

The number of square feet of radiating surface which will be supplied by the heat given up by the water will therefore be

$$680 \div 170 = 4 \; sq.ft.$$

This means that under the conditions stated one pound of exhaust steam having a total available heat of 850 B.t.u. will supply 4 sq.ft. of radiating surface.

Assuming the same drop in temperature and an average water temperature through the radiation of 170 deg., then one gallon will weigh 8.13 lb. and will give up

$$8.13 \times 20 = 162.6 \; B.t.u. \; per \; gal.$$

With a difference in temperature between the room and the water of 100 deg. and a rate of transmission of 1.7 B.t.u., each square foot of radiating surface will radiate 170 B.t.u. per hr. It is evident then that under these conditions, which are average ones, one gallon of water per hour will supply approximately one square foot of radiating surface. The amount of water required under other conditions is shown in Table 2.

Live steam is only used where it is necessary to aug-

TABLE I. SIZES OF STEAM MAINS FOR DIRECT RADIATION*

Drop of Pressure, 100-ft. run. (Unwin Formula). Condensation 0.3 lb. per sq.ft. per hr.

Velocity ft. per sec.	10 ft. Vel.		20 ft. Vel.		30 ft. Vel.		40 ft. Vel.		50 ft. Vel.		70 ft. Vel.		100 ft. Vel.		100 ft. Run 1 oz. drop.	
Size of Main, In.	oz. Drop	Sq.ft. Rad'n	oz. Drop	Sq.ft. Rad'n	oz. Drop	Sq.ft. Rad'n	oz. Drop	Sq.ft. Rad'n	oz. Drop	Sq.ft. Rad'n	oz. Drop	Sq.ft. Rad'n	oz. Drop	Sq.ft. Rad'n	Vel.	Sq.ft. Rad'n
1	0.4	25	1.6	49	3.6	74	6.00	100	10.00	124	19.6	174	40.00	248	15.8	40
1¼	0.29	39	1.16	77	2.61	116	6.64	155	7.25	194	14.21	271	29.00	388	18.5	75
1½	0.2	56	0.8	112	1.80	168	3.20	224	5.00	280	9.8	392	20.00	560	22.5	126
2	....	....	0.48	200	1.08	300	1.92	400	3.00	500	5.88	700	12.00	1,000	29.0	256
2½	....	....	....	....	0.75	465	1.34	620	2.10	775	4.1	1,085	8.40	1,550	34.5	535
3	....	....	....	....	0.56	669	1.00	892	1.56	1,115	3.06	1,561	6.25	2,230	40.0	890
3½	....	....	....	....	....	....	0.85	1,216	1.33	1,520	2.6	2,128	5.31	3,040	43.4	1,360
4	....	....	....	....	....	....	0.66	1,600	1.04	2,000	2.04	2,800	4.16	4,000	49.0	1,950
4½	....	....	....	....	....	....	0.53	2,005	0.83	2,506	1.63	3,508	3.33	5,012	54.8	2,747
5	....	....	....	....	....	....	0.48	2,480	0.75	3,100	1.37	4,340	3.00	6,200	58.0	3,600
6	....	....	....	....	....	....	....	.....	0.57	4,470	1.12	6,258	2.30	8,940	66.0	5,900
7	....	....	....	....	....	....	....	.....	0.45	6,083	0.887	8,516	1.81	12,167	74.3	9,040
8	....	....	....	....	....	....	....	.....	...	.....	0.76	11,130	1.56	15,900	80.0	12,700
9	....	....	....	....	....	....	....	.....	...	.....	0.637	14,095	1.30	20,137	87.4	17,600
10	....	....	....	....	....	....	....	.....	...	.....	0.57	17,360	1.18	24,800	92.0	22,900
12	....	....	....	....	....	....	....	.....	...	.....	.....	.....	0.94	35,800	103.0	37,000
14	....	....	....	....	....	....	....	.....	...	.....	.....	.....	0.78	48,700	113.0	55,300
16	....	....	....	....	....	....	....	.....	...	.....	.....	.....	0.66	63,600	123.0	78,300

* Condensed from "Steam Circulation" Positive Differential System Co.

TABLE 2. WATER REQUIRED PER HOUR PER SQUARE FOOT OF RADIATING SURFACE

Temp. of water, deg. F.	140	150	160	170	180	190	200	210
Wt. per cu.ft.	61.37	61.18	60.90	60.77	60.55	60.32	60.07	59.82
Temp. of rm., deg. F.	70	70	70	70	70	70	70	70
Dif. bet. temp. water and air in room	70	80	90	100	110	120	130	140
B.t.u. emitted per hr. per sq. ft. of radiator per deg. diff.	1.4	1.45	1.45	1.5	1.5	1.5	1.6	1.6
Total B.t.u. per sq.ft. per hr. (Item 4xItem 5.)	98	116	130	150	165	180	208	224
Lb. water to each sq.ft. per hr. if cooled 5 deg. pass'g through radiator	19.6	23.2	26.0	30.0	33.0	36.0	41.6	44.0
Lb. when cooled 10 deg. in passing	9.8	11.6	13.0	15.0	16.5	18.0	20.8	22.0
Lb. when cooled 15 deg. in passing	6.5	7.7	8.6	10.0	11.0	12.0	13.8	14.9
Lb. when cooled 20 deg. in passing	4.9	5.8	6.5	7.5	8.25	9.0	10.4	11.2

ment the supply of exhaust steam and furnish the radiation under contract. This may be delivered through the same set of piping to the heaters as is the exhaust steam by delivering it through a reducing valve, or it may be delivered direct to live-steam heaters which are operated either in series or in parallel with the exhaust heaters. Where exhaust steam is used to heat circulating water, it is usual to deliver it through an oil separator before passing to the heaters, and the condensation from the heaters is used as boiler-feed water.

Circulating Pumps

Both reciprocating and centrifugal pumps are used, but the latter is preferred. It may be either motor driven or connected direct to a steam turbine. The latter is the more economical arrangement when the exhaust from the turbine can be utilized in heating the water. In any system it is usually the practice to install at least two pumps, one of which may carry the entire load and the other be a spare unit. In larger systems sometimes as many as four pumps are installed to operate in parallel and their size is such that a single pump may be out of service and the others still have the capacity to circulate the entire amount of water necessary.

Sizes of Mains

The allowable velocity of water in the flow mains may be as high as 10 ft. per sec. The diameter of the pipe for carrying any amount of water may be easily calculated when the velocity is assumed, but if the piping system is of considerable extent and somewhat complex, it is better to calculate as closely as possible the friction head which will exist under any assumed velocity and if it appears to be excessive, the size of the pipes may be increased sufficiently to reduce this velocity. In any case the problem is one of balancing the cost of the increased power necessary to circulate the water at the higher resistance against the interest cost of the greater investment in larger size pipe.

The flow capacity of pipes of various sizes and for various water velocities up to 15 ft. per sec., are given in a table on page 55 of the July 9, 1912, issue of Power, and cubic feet and pounds per minute are given on page 58 of the same number.

Piping Systems

The two principal systems in use are known as the one-pipe and two-pipe systems. In the one-pipe system the water leaves the heating station through a single pipe and makes a complete circuit throughout the district, returning to the heating plant for reheating. This is sometimes known as the loop system and all radiation is connected on what are practically shunt circuits. In this case a single pipe of uniform diameter sufficient to carry the maximum quantity of water for all the services must be installed, and its diameter may be calculated on a velocity of 10 ft. per sec.

In the two-pipe system a pair of parallel pipes are run throughout the district and returned to the heating plant. Radiation is connected across these two mains in a manner analagous to connecting electrical apparatus in parallel across two circuit wires. The circulation in the two-pipe system is due to the difference in pressure between the water in the going main and the return main at the same point of the conduit. The pressure in the one-pipe system may be consequently less than for the two-pipe system, and in most cases the one-pipe system with a proper layout is preferred.

District-heating systems may be easily adapted to serve the particular heating system in use in any building or residence. For instance, in a private hot-water heating system, the hot water from the central station may be circulated through what is known as a transformer, which is essentially a water-tube heater and which becomes the source of hot-water supply for the house system. It may be adapted to warm-air systems of heating or the plenum system of heating and ventilating, by delivering the water through the indirect coils of such a system. The use of the transformer with hot water, however, is necessary only in exceptional cases, but such an apparatus is more often used where the private system is a hot-water system and the heat supply from the central station is steam.

Temperature Regulation

Regulating the temperature in accordance with the weather conditions in the buildings heated, is most economically done from the power plant. Experience soon shows the necessary temperature of the circulating water to keep the room temperatures, at, say 70 deg., with any given outside temperature. Power-plant conditions can then be adjusted to maintain the necessary water temperature and also the amount being circulated, and this will be found to have a direct bearing on the amount of vacuum which can be maintained at the engines.

❋

Pipe Sizes for Hot-Water Heating

Mr. Durand asks for criticism of his method of determining pipe sizes for forced hot-water heating systems. His table, in the Apr. 1 issue, is most useful for finding the number of square feet of radiator surface that a given pipe will supply when either the friction head or the velocity is assumed, but he does not give any basis for making either of these assumptions. He says: "A more logical method would be to fix the total friction head per 100 ft. and from the total length of the system determine the allowable friction head per 100 ft." How are we to "fix" or "determine" these things with some degree of accuracy?

Suppose we have a system in which the mains are to supply 11,000 sq.ft. of radiating surface and two branches supplying respectively 1200 and 400 sq.ft. What size of pipes should be used? The table gives the following values, any of which might be used:

Rad. Surface Sq.ft.	Size of Pipe, in.	Velocity, Ft. per Sec.	Friction Head in Ft. per 100 Ft.
11,750	5	3.30	1
11,650	4	5.15	3
11,000	3½	6.25	5
1,200	2	1.90	1
1,200	1½	3.34	4
400	1¼	1.50	1
412	1	2.68	4½

In favor of the larger sizes of pipe, with 1 ft. friction head, we have minimum cost of pumping the water. In favor of the smaller sizes we have minimum first cost of piping and covering and minimum loss by radiation from the covered mains. Will Mr. Durand be kind enough to add to his article some statement in regard to his method of selecting the best sizes of pipe for such a problem as the one here given.

William Kent.

Montclair, N. J.

EDITORIALS

Caring for Emergencies

To know what to do in emergencies and to do it quickly and without confusion is an engineer's most valuable asset. It has been said that the difference between a lawyer and an engineer is that when the lawyer gets "stuck" he may have the case delayed while he "looks up precedent" to overcome his difficulty, but the engineer must overcome the difficulty and think about it afterward.

Even though there is no time for the engineer to look up precedent when something happens in the plant, it is well for him to know or to have read of what was done in similar circumstances by other engineers. If he knows what to do the confusion and worry of emergency moments are minimized. Ignorance of what to do begets fear, and a frightened man is a mighty poor adjunct to a power plant. He usually does more damage than he sets out to rectify or prevent.

A good illustration of this was told in POWER sometime ago. The plant was noncondensing, containing three large cross-compound units, the exhaust pipes of which were connected to a common trunk line connected to an open feed-water heater. The float valve controlling the city water supply to the heater became inoperative during the night and flooded the heater and the exhaust line.

When the engineer started a unit in the morning, the water admitted to and entrapped in the low-pressure cylinder, blew out the cylinder head. Instead of investigating, he opened the throttle on the next engine and, to make a long story short, blew the cylinder heads out of all three engines.

On page 611 of this issue a contributor tells of how a duplex mine pump was kept running after the stuffing-box, gland, packing and all, had been blown out. He also describes a repair to a broken cylinder head, water end, of a pump by shrinking a ring in a groove cut in the head while the broken pieces were clamped together. These repairs were of the emergency kind and done as quickly as possible so that the service suffered no serious interruption.

We recall an engineer who had charge of a plant isolated miles from a supply house, railroad and express service. The piston of one unit broke into pieces so small as to make repairs to it impossible. The need of the engine's service was urgent, so from a piece of one and one-half-inch seasoned hardwood board a temporary piston was made by grooving the board to receive a spare set of rings which fitted the old piston. This piston gave satisfactory service until a new one arrived.

The ability to prevent avoidable accidents and keep power-plant apparatus in service under circumstances of distress, is what makes some men better engineers than others.

The way to acquire this ability is to locate the weak and vital spots in the plant and determine what will be the best thing to do should this or that piece of apparatus fail. Trace out the pipe lines and learn what valves must be opened and closed if a bad leak or break occurs in this or that line. In brief, train yourself in the operation of your plant so that you become the man to whom the other men go to when they get "stuck."

Are Your Boilers Safe?

The average engineer, when asked this question, would probably answer by stating that his boilers were regularly inspected by a competent inspector and that he never exceeded the limit of pressure allowed and, therefore, considered his boilers safe. This line of reasoning is perfectly correct as far as it goes; but do you do your part in aiding the inspector to properly diagnose your plant conditions? It is proper and right that dependence should be placed on a specialist in the matter of fixing the safe limit for pressures, but you would not think of paying a specialist to treat you for a disease without answering every one of his questions to the best of your ability and volunteering further information, that you thought might be useful to him in prescribing for you.

The maximum pressure allowable on a boiler is usually determined by a consideration of its construction and the quality and condition of its parts. There are many things to be considered, however, exterior to the boiler itself which go toward making it safe. In fact, the explosion of a sound boiler, due to an overpressure of steam, is not one of the most frequent causes of boiler accidents. In determining conditions external to the boiler itself, the man on the job can be of the greatest assistance to the inspector.

Make the inspector your confidant in all matters pertaining to the question of your plant and, by all means, tell him fully of any changes that may have occurred between his visits—whether you believe they should be apparent or not.

For example, a condition that may seriously affect the safety of your boilers, and which might easily escape the notice of the most competent inspector, is one of strain on the pipe connections produced by improper setting repairs. The setting walls, at the time of the inspector's visit, may be in first-class condition, but when repairs were made, proper attention might not have been given to the adjustment of the position of the boiler so that all strains that might have been produced on the pipe connections, due to settling, would be removed. With several boilers connected to a header, and especially if the connections between the header and the boilers are very short or direct, the engineer should make certain that no strain exists in the connections, due to a shift in position of the boilers.

If the plant is new to the man in charge, he should take the precaution to test the freedom of the piping by unbolting or loosening, the connecting bolts, to see if it springs out of position. Regardless of the theories of boiler explosions, it is well established that the sud-

den breaking of a connection may produce an explosion of the boiler.

If you should be asked if the pipe connections to your boilers were under undue strain could you, from positive knowledge, answer "No?" Better try them the next time the plant is shut down. It may be you cannot force the connections together again after loosening them. Do you want to? If you cannot get repairs made in time to start Monday morning, explain the circumstances to the boss. If his office is at the plant, the chances are ten to one that he will thank you instead of growling.

Police Department to Lose Boiler Inspection Bureau?

Engineers of New York City are again wondering if the Boiler Squad of the Police Department is to be discontinued.

During the Aldermanic Investigating Committee's probing into the conduct of the Police Department, the question of the expediency of continuing in that department, the duties of boiler inspection, was raised. Subsequently the Bureau of Municipal Research investigated the work of the Boiler Squad and submitted its report to the Aldermanic Investigating Committee. The chief parts of this report are printed on page 618 of this issue.

Besides charging previous squads with grafting, the report states that some of the present inspectors were clerks, gasfitters and just ordinary patrolmen before appointment to their present positions. It is also said that one of the examiners was a lumber inspector, time keeper, etc., before assuming his present duties. Nine boiler inspectors are claimed to have to inspect an average of forty boilers a day.

Immediately following these charges the report states that the present squad under Lieutenant Van Keuren is doing better work than previous squads had done. One who did not know the "previous squads" wonders, after reading the report, if they were composed of pirates of the Spanish Main type.

After making proper investigations we conclude that the present squad is really doing as good work as it will be permitted to do. Responsible engineers in the city know that they receive a "squarer deal" from its hands than they have ever received. The taking of fifty dollars with you to insure getting your license is said to be now unnecessary.

With all due commendation to Lieutenant Van Keuren, we again emphasize the importance of taking from the Police Department the duties of the Boiler Squad. The department is no more fit, practically or technically, for the duties than is the Street Cleaning Department. But if these duties are to be transferred to the Bureau of Licenses—and that is where the Mayor wants them—and be subject more than ever to rotten political influence, let them be performed by the police Boiler Squad. It is better to have something that is getting better than something that is worse and will become still worse.

The report of the Bureau of Municipal Research recommends that the office of Commissioner of Public Safety be created, and that this office take over all engineering duties. This recommendation is commendable and we hope to see the office created.

New Jersey's State License Law

New Jersey is the latest state to fall in line with those having state laws providing for the examination and licensing of engineers and firemen. This act is printed in full on page 618 of this issue.

The engineers of New Jersey have worked for over thirty years for a law of this kind and its final enactment must be a great satisfaction to them.

Before this bill was introduced in the assembly, an enabling act was before that body, authoring municipalities to regulate engineers' examinations and licenses by their own ordinances. At the time, we pointed out editorially the weaknesses of enabling acts, showing that instead of being entering wedges, they were additional barriers to progress toward sound license legislation. We were pleased, therefore, to see the present law substituted for the enabling act.

Just as upon all previous occasions, there was strong opposition to the enactment of this law. But it finally passed both houses only to be lost, literally lost, just as though rats had eaten it, before it received the governor's signature. After the legislature had adjourned and late in the afternoon of the last day on which the governor's signing it could prevent the bill being thrown out by default, the "lost" bill was found and signed, another demonstration of the necessity of eternal vigilance in this matter.

Although nothing is said in the bill about grading engineers, it is assumed that the bureau which is empowered to draw up any necessary rules and regulations, will see to it that there will be three grades of licenses.

Despite the favorableness of the new law, we cannot refrain from expressing regret that it does not provide also for the inspection of steam boilers. New Jersey with her numerous and rapidly expanding industries needs such laws to go hand in hand with the recently enacted license law. One law or set of laws is not complete without the other. The greatest good to the public, to manufacturers and to engineers cannot be realized until both laws are jointly enforced.

We are pleased to see the enforcement of the law and the establishment of the license bureau come under the Commissioner of Labor. The work Commissioner Bryant has done in having safety devices installed in factories and in securing fire prevention legislation is good evidence that the license bureau will be well conducted. If a department of boiler inspection is created, we hope it will take over the license bureau and be placed in the Department of Labor.

"There's nothing so bad but it might be worse," is rather melancholy cheer. Nevertheless, it does us good to get our minds off from our own troubles occasionally by thinking of another's. Then when we come back to our own they do not seem quite so serious. So we hope that the verses on our foreword page may put new courage into the hearts of some of our firemen friends, who, perhaps, did not know any could be quite so unfortunate as they, until they heard of the Mallet firemen.

Does not the contemplation of such a power plant as the new Northwest Station of the Commonwealth Edison Co., described in this issue, make you proud of this day and generation and the profession with which you are connected?

READERS WITH SOMETHING TO SAY

Emergency Repair Kinks

The two emergency repairs described below were recently made to pumps in an Australian mine.

The whole stuffing-box blew out of the cover of the water cylinder of a duplex pump. When the engineer reached the pump room the water was 2½ ft. deep and rising rapidly.

Two screw jacks were quickly made out of ⅝-in. round iron, pointed at one end and screwed into a long nut at the other end. The broken parts were then treated with white lead, pushed back with packing in the stuffing-box and the screw jacks then placed in position between the broken stuffing-box and the steam-cylinder cover.

This job made good until the receipt of a new cover and stuffing-box from Sydney.

A direct-acting steam pump lost the water on one side and the piston broke the cylinder head. The cylinder had a bore of 12 in. The cover was broken into three pieces, equally divided at almost 120 deg. each.

The three pieces were clamped together in a lathe chuck and a groove 6 in. in diameter was turned on its face. The broken surfaces were then painted with red lead and a mild steel ring shrunk into the groove.

This job held against a pressure of 135 lb. per sq.in. until a new cover was received.

W. Vincent Treeby.

Goodmayes, Eng.

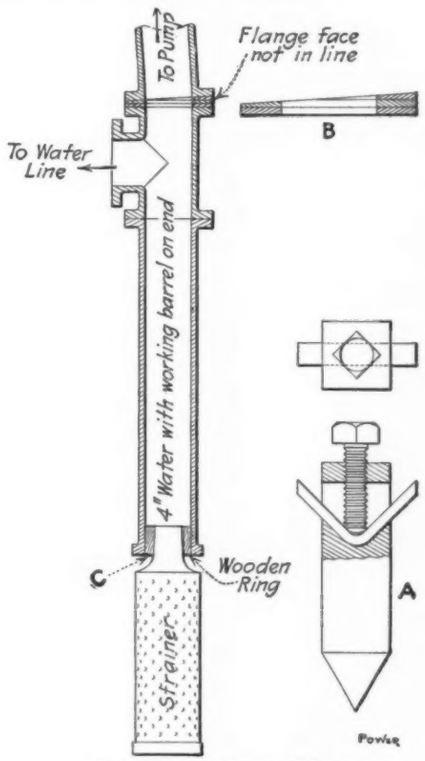
❖

Deep Well Pump Problem

How water was raised from a 6-in. driven well when the water level had dropped may be of interest. The well was 90 ft. deep and when the pump was first installed the working barrel was in 15 ft. of water. As the water delivered was continually getting less, steam and water pipes leading to the pump were disconnected and after sliding the pump aside, the sucker rods and working barrel were pulled out. By dropping a line down we found but 2 ft. of water in the well, a drop of 13 ft. in the eight years the well had been in service.

After pulling out the old strainer and lowering a new one, the sand was pumped from under it until there was 12 in. of strainer left in the casing. To make a watertight joint between the strainer and casing a wooden ring *C* was made, wedge shape to fit inside of the casing and outside of the strainer collar, which was driven tightly into the ring. As the new strainer was 15 ft. longer than the old one, there was 17 ft. of water in the well.

The working barrel was double-acting and it was necessary to use a 1-in. wrought-iron pipe instead of the old wooden sucker rods. After lowering the working barrel in place and when about to connect the pump, it was found that the flange tee connecting the pump to the water line was ½ in. out of square, as at *B*, so a gasket of several pieces of sheet rubber was made, the first piece being whole, the second one had a piece cut out and so on until it was of the right shape. After putting red and white lead between each layer of rubber the flange was bolted together; the pump delivering 50 per cent. more water than when it was first installed.



Casing of Deep Well

At *A* is shown a tool made for pulling out the old strainer, a piece of 1½-in. square iron was slotted to receive the steel jaws with a setscrew to hold them in place.

W. Chuisana.

Brooklyn, N. Y.

❖

Losses Due to Compressor Piping

In the steam plant, of which I have charge, there was installed, shortly before I came, a single-stage 8 and 10 by 8-in. steam-driven air compressor. Contrary to the advice of the engineer and the agent who sold it, the owner insisted on setting up the machine in a small room something over 100 ft. from the boiler.

The steam line was 2 in. in diameter throughout its length and, due to an oversight in installation, was connected with a 2-in. line already heavily loaded. As a result, the machine not only failed to do the work, but the cost of operating was far above what the owner had expected.

I advised moving the machine to the engine room near the boiler, or, at least, to pipe it to a separate steam line, but nothing was done and it was impossible to convince

the owner that the long steam line was the direct cause of the trouble, until I put a gage on the steam pipe at the compressor throttle, which showed scarcely 70 lb., although the boiler gage showed 100 lb. pressure.

After this, there was no longer any question about moving the machine, which was done at once. The following shows the result obtained by the change in steam and air lines: Before moving the machine it ran at 200 r.p.m. with a maximum air pressure of 20 to 40 lb. per sq.in. at a cost for coal of $55 per month. After moving the machine the revolutions were reduced to 135 per min., but the air pressure was increased to from 50 to 70, while the fuel cost per month was $29.

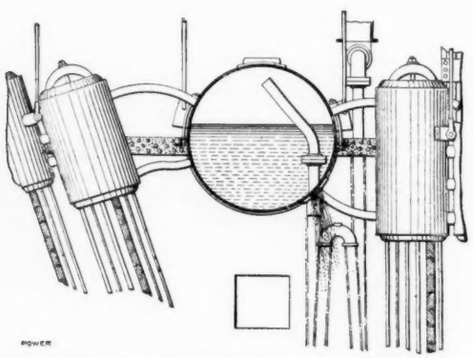
A. D. Palmer.

Roxbury, Mass.

Leaking Nipple Disables Superheater

We did not fully realize what 75 deg. superheat meant to our 3000-kw. turbine, until one day it refused to carry the overload it usually carried with a slight increase in coal consumption.

The illustration shows an end view of the steam drum, three units and the superheater of one of our boilers.



Showing Leaky Nipple Which Disabled Superheater

There are three 4-in. pipes leading from the steam drum to No. 1 superheater header. The nipple connecting one of the rear units to the steam drum leaked badly and the water sprayed on the superheater as shown. This turned the superheater into a condenser.

Thomas Sheehan.

North Adams, Mass.

An Object Lesson

Over one-half of the business places in this city were in darkness the night of Mar. 25, the Cleveland Electric Illuminating Co. being unable to supply current, because its plant was flooded. Our largest stores were compelled to close up long before their usual time and their loss in trade will amount to many thousands of dollars. This perhaps opened the eyes of some of our business men to the fact that had they plants in their own buildings they would have been able to accommodate their trade instead of turning them away and losing a large part of what such a plant would cost them.

Nearly all the light in the business section was furnished by the isolated plants, and these buildings loomed up as monuments of foresight and prudence.

O. N. Pomeroy.

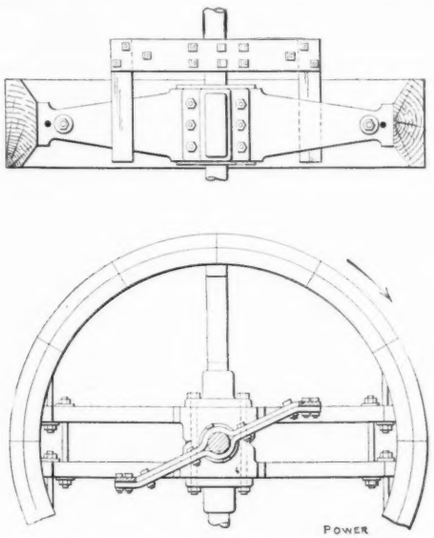
Cleveland, Ohio.

[Central stations must locate near a river or other plentiful supply of water and are thus endangered by floods. The Cleveland experience was unusual on account of the extraordinary floods.—Editor.]

Repair to a Slipping Pulley

A large split wooden pulley in our plant gave much trouble, due to slipping on the shaft.

To correct the evil a clamp, shown in the illustration, was securely fastened to the shaft next to the hub of the



Clamp with Extension Pieces to Prevent Slipping of Pulley

pulley. Two strips of hardwood were then bolted to the clamp at each end and projected into the pulley so as to each bear against the opposite sides of the pulley frame.

The arrangement works well, and the normal load is carried without fracture to the clamp.

Frederick L. Johnson.

Paterson, N. J.

Repairing a Leaky Flange

In a main supplying steam to two high-speed compound engines the flange *B*, Fig. 1, developed a leak at *C*. Due to the method of calking the steam pipe in a recess cast or turned in the flange, it became a difficult problem to stop the leak. Fig. 2 shows how the pipe was flanged over into the recess *D*. Obviously any attempt at screwing the flange along the pipe would increase the leak.

To effect a permanent repair the best way would have been to take down the length of pipe, leaving the flange *A* attached, and calk the pipe back in the recess. This method would have entailed considerable labor and time, and it would have been necessary to shut down the plant for at least two days. Rather than do this it was decided to make the repair in the following manner:

The steam main is 14 in. in diameter and carries a pressure of 250 lb. per sq.in. To effect the repair a pattern was made for a split cast-iron flange, Fig. 3, to

fit the steam main. Another pattern was made from which to cast a copper ring, Fig. 4, of suitable size to encircle the pipe. The holes in the cast-iron flange were drilled to correspond with the holes in the flange on the pipe. The copper ring was split as indicated and fitted with straps to hold the two halves together. The main flange had twenty-two ¾-in. bolts and the split flange 14 bolts, as the full number could not be inserted on account of the flanges at *EE*, Fig. 3.

When the split flange and copper ring were ready, the steam pressure was allowed to fall at an opportune time and the main stop valve was closed on the line. At the leak the surfaces of the flange and pipe were cleaned

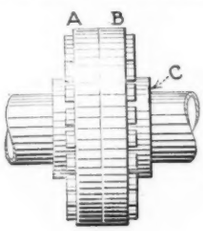


FIG. 1

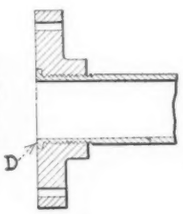


FIG. 2

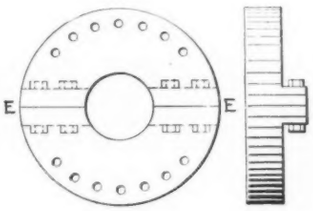


FIG. 3

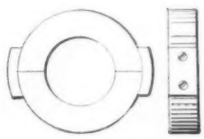


FIG. 4

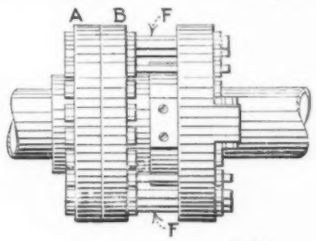


FIG. 5

and a heavy quality of tinfoil was calked into the crack. One turn or ring of heavy copper wire was placed around the pipe and against the tinfoil, the ends of the wire being soldered together. The soft copper ring shown in Fig. 4 was placed around the pipe. The split cast-iron flange was now placed on the pipe, bolted at *EE* and pulled into place by means of the long ¾-in. bolts shown at *F*, Fig. 5, which passed completely through the three flanges. Each bolt had two nuts, as shown. A permanent and satisfactory job was thus completed without shutting down the plant or incurring the expense of outside labor.

WILLIAM KAVANAGH.

New York City.

Radiator as Closed Heater

In many small plants the drips from steam kettles or other apparatus return to a hotwell, from which they are pumped back into the boiler at a more or less high temperature, generally less, while the exhaust from the boiler-feed pump probably blows away into the atmosphere.

A simple arrangement for improving both of these conditions is to place an old radiator in the hotwell (one with a top-feed inlet preferred) connect the exhaust pipe from the feed pump into the top feed and let the exhaust outlet be from the bottom, and opposite end of the radiator. This converts the so called hotwell into one in reality, the radiator acting as a closed heater.

JAMES E. NOBLE.

Toronto, Ont., Canada.

Engine Wrecks and Remedies

How many engineers ever examine a broken piece of machinery and study it—not only how to best repair it as soon as possible, but with a view of changing the design so that the weakness will be eliminated and another break in the same place prevented? It is sometimes a good investment to substitute bronze for brass and for cast iron, and steel for cast iron.

One night the dome, attached by a nipple to a horizontal return-tubular boiler, blew off. The boiler was connected with a header and two other boilers carrying 100 lb. steam pressure. The accident occurred a short time after the engineer opened the feed-water valve to put two or three more inches of water into the boiler before firing up for the peak load.

When the dome was examined it was found that the flange had been slipped over the reduced part of the dome and that the inside of the dome nipple was peened with a hammer in but five or six places. How the boiler ran without trouble for several years with such dangerous and criminal construction is not understood. A 4-in. pipe and flange took the place of the dome, which removed the dangerous feature.

Automatic boiler-stop valves should be placed in the main outlet as close to the boiler as possible and a gate valve put in close to the header. A drain pipe should be put in the bend or the pipe between the automatic and header valves. When a boiler is cut out for cleaning, the automatic and header valves should be closed and the drain valve opened to the atmosphere so that no water can accumulate in the pipe.

After a boiler has been thoroughly cleaned and the automatic valve examined, if necessary, it should be left wide open so that when the steam is slowly raised in the boiler the automatic valve will raise the disk and allow the pipe connecting with the header to slowly warm up and trap the water back into the boiler. When the steam gage on the boiler and the battery and header register the same, the boiler should be cut in.

A bypass valve around the header valve is handy if it is desired to warm up the pipe connecting the boiler and header and equalize the pressure before opening the header valve.

In a pumping plant a pump worked against a pressure of 625 lb. per sq.in. The crank rod broke, due to the crankpin working loose in the crank disk. The design was changed and the crankpin and disk made in one piece, although it cost about twice as much as the standard crankpin and crank disk.

In another plant the 4-in. crankshaft of a high-speed, tandem-compound, 80-hp. engine crystallized and broke close to the disk. In the opinion of the writer the crankshaft should have been at least 6 in. in diameter, and a lighter flywheel used.

As to pumps, a brass or babbitt ring, making a nice fit in the oil end of a crude-oil pump will save hydraulic packing. Cast-iron snap rings in the water end of a boiler-feed pump will last many times as long as hydraulic packing, if there is considerable sand or grit in the water.

Pasadena, Calif. W. M. GLASS.

QUESTIONS BEFORE THE HOUSE

Buckling of Boiler Tubes

Being particularly interested in this subject I read the letter of C. S. Davis, on page 427, and the several letters that had preceded it, hoping to get a view of the matter from some new angle. From quite a varied experience with tube troubles of this character, I find that all the correspondents on the subject have apparently correct points of view in some respects; but all of the views of none coincide with my experiences along this line.

W. A. McCooll's contention (as expressed in the July 9 issue) that differences in temperature between the inner and outer surfaces cause differences in the expansion that gradually rack the tube can hardly be assumed to be reasonable. Experiments on the transmission of heat through boiler surfaces have shown that practically all the resistance to heat transmission is experienced in getting the heat into the metal surface and from it into the water, the resistance to the transmission of the heat through the metal itself being practically negligible, particularly so for very thin surfaces, such as boiler tubes. Without appreciable resistance to the passage of the heat we can assume no considerable differences in the temperature between the inner and outer surface of the tube.

Mr. Davis' first letter, on page 313 of the Aug. 27 issue, is evidently considerably in error. In the first place, as pointed out by the editor, it is possible to overheat a clean tube under certain conditions, that is, a tube that would be considered clean for boiler operation. If a tube had a polished surface in contact with the water, it would be much more difficult to overheat it. Mr. Davis' statement that the tubes of water-tube boilers always bow upward when overheated by scale deposits is not borne out by my experience, which has been that the tubes on the lower rows of vertically baffled boilers, such as the B. & W. type, are likely to bow in almost any direction, with possibly a slight preference toward sagging. In horizontally baffled boilers, such as those of the Heine type, the decided preference is toward upward bowing, notwithstanding the fact that, to bow in this manner, the weight of the tile baffles, as well as that of the tubes themselves, must be raised.

The common theory is that a tube will be bowed convexed on the hot side and to explain the eccentricity of the bowing of the tubes in the horizontally baffled boilers, it is usually assumed to be caused by the overheating of the upper part of the tube produced by its contact with the hot baffle tile, when the boiler is emptied too soon after shutting down. This theory has failed to appeal to me, because I have known instances of such distortion where it was certain that no such careless methods had been pursued. The question naturally arose as to whether a tube would necessarily bow convexed on the heated side; and an experiment with a gasoline torch soon convinced me that the bending would be just the opposite if the tube was heated locally in spots. The explanation for this is, that when a spot on a tube is heated, the stiffness of the structure prevents distortion to such an extent that the metal at the heated point will be upset and when the tube returns to a uniform temperature in all parts the heated side is shorter than the opposite one. If a boiler of the horizontally baffled type is fired dry the bottom tubes will sag, due to the weight of tile on them. Mr. Davis' theory regarding the presence of scale in half the tube, holding it so that it will concave on that side, is preposterous.

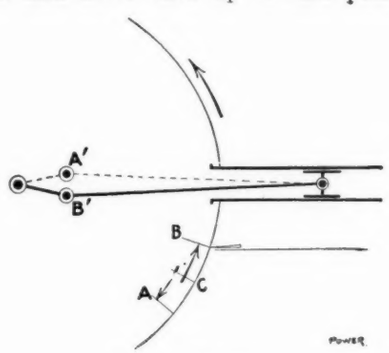
On the whole, Mr. Summer's experiences and ideas coincide with mine on this subject, except as to the bowing of the tubes in the horizontally baffled type of water-tube boilers, and here our experiences have been diametrically opposed.

J. E. TERMAN.

Hartford, Conn.

Valve Setting

In POWER's booklet, "Valve Setting," on the second page of the article, "Setting the Valve of a Slide-Valve Engine," is the following statement regarding locating the dead center of an engine: "Always turn the engine in the direction in which it is to run to bring it to a given point and never back up to that point." These



VALVE SETTING

may not be the exact words used, but they convey the same meaning.

I do not agree with this. My theory and practice is always to turn the engine in the opposite direction in establishing such points, because the pressure on the piston on the outstroke puts the connecting-rod, etc., in compression and, to have it again in compression when the engine is turned over by hand (by a force applied presumbly to the flywheel), it must be turned in the opposite direction to the normal running direction. The same facts hold for the return stroke.

Referring to the accompanying sketch, if the engine runs in the direction of the large arrow, then, to locate points *A* and *B*, the engine should be turned in the direction of the arrows at those points. *C*, the center, will be half way between.

The method just detailed will properly take care of all

back lash in connecting-rod, crosshead, etc.; but works just wrong for the back lash in the valve-gear. If the back lash in the valve-gear is greater than the back lash in the connecting-rod, etc. (which it is likely to be), the engine should be turned just opposite to the direction I previously stated.

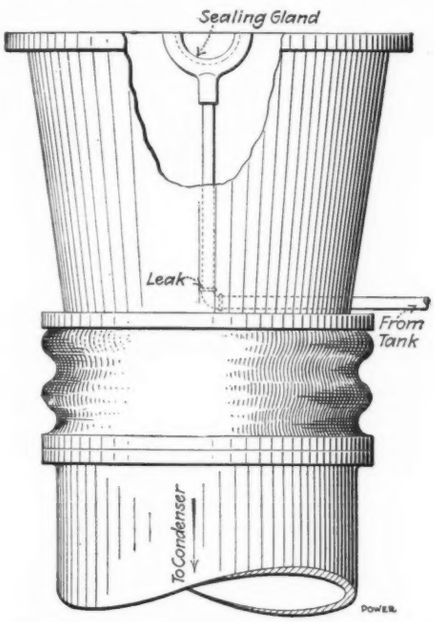
Setting a valve after all is not altogether a simple operation.

FRED E. WALCHLI.

Katispell, Mont.

Why Vacuum in Turbine Decreased

Referring to the turbo-condenser problem of Stanley C. Allen, in the issue of Jan. 7, I would state that I have experienced similar trouble with the vacuum in a turbine of the same make. This type of turbine (Parsons) has a water seal of about 5 lb. per sq.in. (sustained by the head of water from a tank elevated about 11 ft.) to prevent air leakage at the ends of the turbine shaft. In



SHOWING LEAK IN SEALING-WATER PIPE INSIDE OF TURBINE-EXHAUST END

the case I refer to the vacuum dropped to 15 in. It was discovered finally that the pipe supplying water to the seal at the exhaust end of the turbine was leaking. This pipe entered the exhaust end of the machine and continued on to the water seal, as shown in the sketch. As the leaking elbow was inside the casing it could not be seen. Perhaps Mr. Allen's turbine was likewise affected.

JOHN F. HURST.

Louisville, Ky.

Air-Receiver Explosions

I have read with great interest the letter by Letson Balliet on "Air Receiver Explosions," in the Mar. 4 issue. I have often noticed large deposits of grease and dirt in receivers, especially in the bottom of vertical receivers, and think that a large portion, if not practically all, of this deposit might be prevented from ever reaching the receiver. For instance, in using the exhaust from a reciprocating engine a separator is usually provided for removing cylinder oil, unless the steam is for some process where it does not matter. Where the steam does not come into direct contact with the process it is advisable to remove the oil or otherwise it will form a heavy deposit and prevent the passing of heat efficiently. Again, take an ammonia compressor. This is always provided with a separator to remove the lubricating oil. Would it not be worth while for one of our readers who may have the opportunity, to insert a separator between his compressor and receiver and let the other readers of POWER know the results?

So far as lubrication goes, there is not much chance of this being properly done unless the engineer will fit mechanically driven lubricators and set them himself, so that the attendant need only fill them. The supply of oil will then be controlled by the piston speed, which is the object required.

E. R. PEARCE.

Rochdale, Eng.

Guards for Flywheel Keys

Recently a reader suggested, for locking keys in place, using a filling-in piece placed behind the key and held in position by a countersunk screw. Fig. 1 shows a means I have seen for shielding keys of gas-engine flywheels.

The illustration needs little explaining, *A* being the crankshaft; *B* the boss, or hub, of the flywheel; *C* a cast-iron cap held in place by a screw *D*.

Primarily this arrangement is to protect against accidents from the key catching one's clothing, but it is also useful as a stopper or lock for the key.

At Fig. 2, is shown the same arrangement applied to

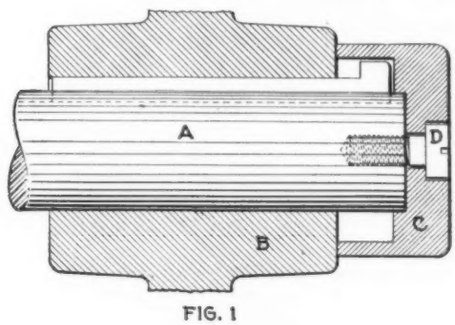


FIG. 1

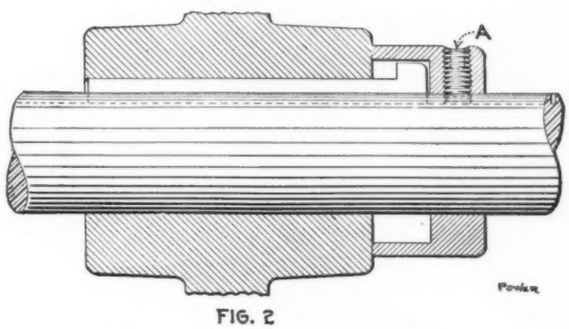


FIG. 2

GUARDS FOR FLYWHEEL KEYS

a key away from the shaft end. This is an ordinary collar recessed to pass over the key head and held in place by a setscrew *A*, which may be sunk into the keyseat slightly as a greater protection.

F. P. STRACHAN.

Belfast, Ireland.

INQUIRIES OF GENERAL INTEREST

Cloth Pinion Lubrication—How should cloth pinions be lubricated?

H. C. V.

An application of graphite once a month will keep them in good running condition.

Rivets under Shear—In a quadruple-riveted joint how many rivets are in double and how many are in a single shear?

C. O. B.

There are eight rivets in double and three in single shear.

Gas-Engine Thermal Efficiency—Do large gas engines have a higher thermal efficiency than small ones?

J. J. C.

The thermal efficiency of an internal-combustion engine is practically independent of the size. It depends on the initial compression, fuel used, thoroughness of mixture or carburization, jacket-water temperature and the general design of the combustion chamber, involving the proportion of area to volume.

Acid-Proof Ventilators—Our galvanized-iron ventilators, exposed to sulphur fumes and rain, rust through in a year. What causes it? Would copper last longer? If not, what is better?

W. C.

Moisture, taking up the sulphur fumes, forms sulphuric acid, which is destructive to galvanized or ungalvanized iron. It attacks copper almost, if not quite, as readily. Wood would be the least affected, but must be painted anyway, so that it would be just as well in the long run to use iron thoroughly painted with asphaltum, or better, P. & B. paint.

Motors Starting Under Load—Where an alternating-current motor must be started under load, what type motor should be used?

P. J. P.

A synchronous motor has a small starting torque, hence cannot be started at full load. The wound rotor, or high-resistance type of induction motor, may be started under load as it has a large starting torque, but the ordinary squirrel-cage induction motor has a comparatively small starting torque.

Good references to read in this connection are the discussion of different types of motors and their characteristics in the article by A. B. Morrison entitled "Motors and Motor Applications," printed in "Power," Feb. 25, Mar. 4 and Mar. 11, 1912, and "Signification of Torque," by Franklin Van Winkle in the Mar. 4, 1913, issue.

Sulphur in Oil—In oil fuel for Diesel engines is a high percentage of sulphur injurious?

H. McC.

Owing to the high temperature within the combustion chamber of the Diesel engine the sulphur is presumably burned completely to sulphur dioxide (SO_2) or sulphur trioxide (SO_3). Neither of these will attack the metal. Combined with water, however, they form sulphurous and sulphuric acids, respectively, which are injurious. This action is very improbable within the cylinder because of the high temperature. However, with a long exhaust pipe subject to cooling, it has been found that the exhaust gases will be sufficiently reduced in temperature for the contained moisture to condense, this condensation absorbing the SO_2 and SO_3, the acid formed attacks the exhaust pipe. Just what percentage of sulphur may be considered detrimental is largely a matter of personal opinion. Both the British and the United States Navies fix a maximum of 0.75 per cent.

Cylinder Lubricant—What grease would be best as a cylinder lubricant in place of oil? Our exhaust steam is returned to the boilers without any oil separators. Would the grease have any effect on the boilers?

M. B.

Grease for cylinder lubrication has generally been discarded since oil manufacturers have been able to furnish oils suitable for almost any requirements of steam temperature and other conditions. Greases can be furnished suitable for cylinder lubrication, but no grease will distribute itself as positively and uniformly as the proper cylinder oil. Grease also has to be fed by some type of pump and is sure to gum and carbonize in any pockets in the steam chest or cylinder. Any cylinder lubricant will be carried over in the exhaust. Grease would tend to collect in spots and be all the more likely to cause burning out of the boiler sheets. A separator would remove as much grease as oil from the exhaust steam, but even with a separator the boiler should be frequently inspected and cleaned when condensed exhaust steam is returned to it as feed water.

Water Hardness—When a water is said to be hard, what proportion of calcium carbonate or calcium sulphate does it contain?

E. J. H.

Whether water is considered hard or not depends on its intended use. For that reason hardness is generally stated in degrees and the allowable degree for any given use specified. According to Clark's standard, a degree of hardness consists of one grain of calcium carbonate, or its equivalent of another calcium or magnesium salt, in 70,000 parts of water (one English gallon of 277.274 cu.in.). Reduced to the American gallon of 231 cu.in., the standard becomes 1 grain to

$$\frac{277.274}{231} = 1.2 \text{ American gallons.}$$

For boiler use water is considered hard if it contains over 5 to 7 grains of the salts to a gallon, that is, if its hardness is more than 6 or 8 deg.

Mathematics Problems—Two questions I would like to have solved (a) A wishes to row across a river 2 miles wide to a point B exactly opposite. He can row it in ½ hr. The current moves down stream 3 mi. per hr. What direction, with reference to B must he take and how far must he row to reach B? (b) A ball rolls 40 cm. down an incline in 1 sec. The incline is 500 cm. long. One end is 40.8 cm. higher than the other. What is the value of g (the acceleration of gravity)?

F. D. S.

(a) When A rows across the river he covers a path, with respect to the moving water, that is, the hypotenuse of a triangle having an altitude of 2 miles and a base of 1½ miles (the distance the water travels in the time the man crosses the river—½ hr.). These two sides of the right triangle are in the ratio of 3:4 and of such a triangle the hypotenuse is as 5, so that it actually is 2½ mi. That is, the distance A has to row and the direction he takes with respect to B is upstream at an angle, the sine of which is $\frac{1.5}{2.5} = 0.6$, or very closely 37 deg.

(b) The acceleration parallel to the plane will be found from the formula

$$s = \tfrac{1}{2}\ pt^2$$

where

s = Distance = 40 cm.
p = Acceleration = ?
t = Time = 1 sec.

Then

$$40 = \frac{p}{2} \times 1 \qquad p = 80 \text{ cm. per sec.}$$

From this and the ratio of the height to the length of the plane, the acceleration of gravity g may be obtained from the formula

$$a = \frac{h}{l} \times g$$

where

a = Acceleration = 80 cm. per sec.
h = Height of plane = 40.8 cm.
l = Length of plane = 500 cm.

$$80 = \frac{40.8}{500} \times g$$

$$g = \frac{80 \times 500}{40.8} = 980.39 \text{ cm. per sec.}$$

ENGINEERS' STUDY COURSE

Principles of Combustion—II

Measurement of Heat

Now, before we take up combustion, coal analysis and similar subjects, we ought to get a good working idea about how heat is measured because it is necessary to measure the heat generated and absorbed so as to know what results we are getting.

Heat is measured by its intensity or degree and by its amount or quantity. If you lighted an ordinary match and held it so the flame struck the business end of a quick-acting thermometer that could stand the treatment, the thermometer would indicate a certain temperature, let us say 400 deg. Then, if you lighted two matches and held them so that both flames struck the thermometer it might astonish you when you found the thermometer showed only the same temperature as before. You could

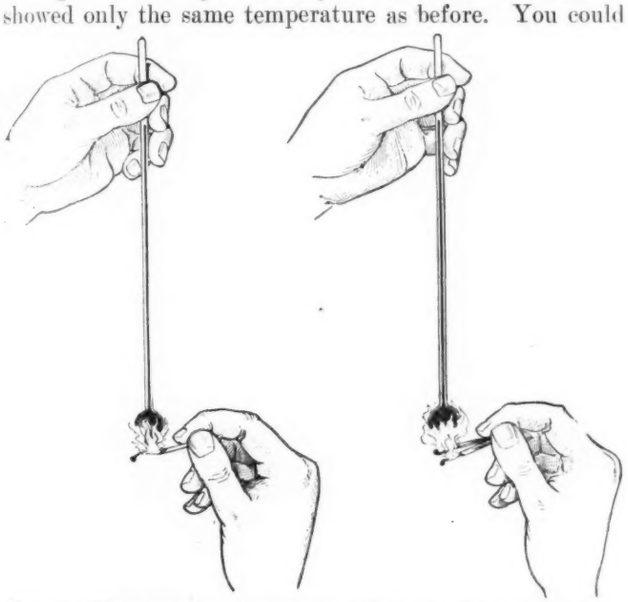


Fig. 2. Experiment to Show That a Flame's Temperature Is Independent of Its Size

easily see that there was twice as much flame and it stands to reason that there was twice as much heat because you were burning two matches instead of one and two matches have twice as much wood as one. Then, why was not the temperature twice as great? Because the temperature or the intensity of heat depends upon the nature of the fuel and the way it is burned while the amount burned determines the quantity of heat created. The fire under a 50-hp. boiler may be just as "hot," the temperature may be just as high, as the one under a 500-hp. boiler, yet it does not do as much work, that is, heat as much water, because it does not burn as much fuel and consequently does not generate as great a quantity of heat.

Now, it is seldom possible to measure the quantity of heat direct, but it is quite easy to calculate the quantity when the temperature and a few other factors are known. This is true because heat acts according to fixed laws, the same as everything else in this world. And when you once understand those laws it is easy to figure out what will happen when certain conditions prevail.

Definition of B.t.u.

The thermometer measures temperature or heat intensity and the unit of temperature is the degree. According to the Fahrenheit scale, which is the one commonly used in this country, melting ice has a temperature of 32 deg. and boiling water a temperature of 212 deg.

The unit of heat quantity commonly used is the British thermal unit or the B.t.u., as it is usually written and pronounced. It gets its name from the fact that British scientists established it or used it first and the word thermal means heat or warmth. Another way of expressing it would be, British unit of heat measurement. In fact, we often use the term heat unit when we really mean B.t.u.

One B.t.u. is the quantity of heat required to raise the temperature of one pound of water one degree.* As a gallon of water weighs $8\frac{1}{3}$ lb., it requires $8\frac{1}{3}$ B.t.u. to raise the temperature of one gallon one degree, or $16\frac{2}{3}$ B.t.u. to raise the temperature two degrees, and so on.

Thus, when a given coal is said to have a heat value of 13,800 B.t.u. per pound, it is meant that if all the heat caused by the complete combustion of one pound of that coal could be transmitted to 13,800 lb. of water it would raise the temperature of that water one degree. Or, if all the heat could be transmitted to, say 138 lb. of water, it would raise the temperature of that water just 100 deg., because

$$138 \times 100 = 13{,}800$$

The pounds of water heated multiplied by the number of degrees the temperature has been raised equals the number of B.t.u.

Indeed, the standard method of finding the heat value of a fuel is to burn a small sample of it in a tight steel bomb under water. The heat caused by the burning of the sample is then all absorbed by the water and by multiplying the weight of the water by its rise in temperature and dividing by the weight of the sample, the heat value of the coal is calculated direct in B.t.u. per pound. Thus, if we burned a small sample weighing one-five-hundredth of a pound in a bomb immersed in 5 lb. of water and if the temperature of that water increased from, say, 70.4 deg. to 75.92 deg., a rise of 5.52 deg., the heat value of the coal would be

$$\frac{5 \times 5.52}{0.002} = 13{,}800 \; B.t.u. \; per \; lb.$$

*This is only approximately true. It takes a different amount of heat to raise a pound of water from 32 deg. to 33 deg. from what it does to raise it from 100 deg. to 101 deg., or from 211 deg. to 212 deg. The B.t.u., therefore, is variously defined as the amount of heat necessary to raise a pound of water 1 deg. at its temperature of maximum density, about 39 deg.; or, at some arbitrary temperature, 60 or 62 deg., because that is assumed to be the average temperature of the surrounding air when experiments to determine the amount of heat are made; or $1/_{180}$ of the amount of heat required to raise a pound of water from 32 to 212 deg. (the average amount of heat per degree). The latter definition is finding the most favor.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Have you noticed the fearful frequency (in the daily press) of the blowing out of cylinder heads of large boilers? This is an awful menace to our safety. Boiler manufacturers should be more careful how they put in these boiler cylinder heads.

❖

A Philadelphia manufacturing concern is said to pay each man 15 cents a day extra provided he takes a bath at night before going home. Just how do you think we had better handle this item? It looms large with possibilities, but— What's the answer?

❖

As an instance of good discipline "below decks," the daily press says that the crew of the "Cincinnati" fought fire in the coal bunkers for three days before reaching port. The first the passengers knew about it was when they landed and read it in the papers.

❖

Here's another tale of the sea—a whaling good one, but its veracity is questioned. Capt. Tutt, of the Hamburg-American liner "Carl Schurz," is said to have reported that the ship while crossing the ocean spitted a whale. "The whale was alive and its whirling flukes sent the ship's bows to starboard." Oh, tut, tut, Tutt, and good night Schurz! You're out of order; this is the closed season for whales, and spitting is forbidden by the statoots.

❖

American consulting engineers come high in the land of the frijole and the hot tamale. Mexican brigands want $10,000 to release one perfectly good engineer. Another had to pay $20,000 before he could resume his consultations, the Greasers having riz the tariff on him. Would be wise for engineers to include a "ransom" cost in figuring on future Mexican propositions.

❖

A statistical fiend in Washington says "we" drink $2,000,000,000 worth of liquor, smoke $1,200,000,000 of tobacco and "absorb" $120,000,000 of soft drinks. With our constantly increasing population, possibly we need this fair amount of liquor to keep up our spirits, but what a wicked waste for soft drinks! And who is meant by 'we"? Let's have a bill of particulars.

❖

If you were asked to give your definition of a gentleman, we bet one of those new nickels that looks like a button on little Lizzie's winter coat that you can't do better than this:

"A man that's clean inside and out; who neither looks up to the rich nor down to the poor; who can lose without squealing and who can win without bragging; who is considerate of women, children and old people; who is too brave to lie, too generous to cheat, and who takes his share of the world and lets other people have theirs."

And this standard works out as well for the overalls as for the joyous habiliments of swell society.

❖

Engineer Hill, of the Middletown pumping station, deserves great praise for sticking to his post for forty hours during the recent flood, but he must regret that the daily press got a hack at the story. It has Jules Verne's "Twenty Thousand Leagues under the Sea" permanently submerged. His station—and Hill in it—disappeared "below the raging water." But dip in and help yourself!

"They could not find the roof of the structure, and the hearts of the men were heavy. Finally Friday morning the peak of the roof of the station appeared above the water and in an hour or so the waters were down sufficiently to cut a hole in the roof. To the astonishment of the rescuers, Hill was found safe and sound, still able to feed the engine with fuel, and though somewhat haggard and ghastly looking from lack of pure air and weak from thirst and hunger, he was in splendid condition after a few square meals. There was no difficulty in getting his first meal, and the cheers that greeted the announcement of the safety of the engineer repaid him for the hair-raising experience of hearing the swish of the waters around, over and almost under him for forty hours."

The reporter failed to say if Mr. Hill got wet or that closing the windows may have saved him.

New York Police Department to Lose Boiler-Inspection and Engineers' License Bureau?

During the Aldermanic Investigating Committee's probing into the conduct of the New York Police Department, the point was raised as to the advisability of continuing under that department, the duties of boiler inspection and examination and licensing of engineers and firemen.

The Bureau of Municipal Research subsequently reported on the condition of this branch of the police department.

The bureau cannot comprehend why the inspection of boilers should be performed by the police department. The report then goes on to show why the department is unfit, practically and theoretically, for performing such duties. Charges of graft are made against inspectors, although the report admits that the present squad under Lieut. Van Keuren is far superior to previous squads.

The training of some of the present squad previous to their service as "engineers" has been as follows:

Boiler inspector, previously letter carrier, clerk and gas fitter; boiler inspector, previously fireman and oiler; boiler inspector, previously patrolman; examiner, previously clerk, lumber inspector and time keeper.

It is stated, also, that there are only nine boiler inspectors and these must inspect on an average of 40 boilers a day.

The bureau recommends the creation of a Commissioner of Public Safety, appointed by and subservient to the Board of Estimate and Apportionment, and that all engineering duties be removed from the police department and assumed by this commissioner whose salary is recommended at from $10,000 to $12,000 a year.

The report embodies several suggestions as to inspection of boilers, specifications as to the use, installation and location of various forms of refrigeration machines. More rigid inspection of elevators is recommended. There are some parts of the suggestions relative to the grading of engineers and the kinds of plants which they may operate, that are objectionable, but as they are only suggestions, they are of little importance.

Editorial reference is made to this report on page 610 of this issue.

❖

New Jersey State License Law

The act printed in full below, to which editorial reference is made on page 610, was signed and became a law, at the closing hours of the April special sessions of the New Jersey Legislature.

SENATE COMMITTEE SUBSTITUTION FOR ASSEMBLY BILL NO. 338, STATE OF NEW JERSEY, MARCH 25, 1913

AN ACT to provide for the examination and license of engineers and firemen having charge of stationary and portable steam boilers and steam engines, and to prohibit the use of such steam boilers and steam engines unless the person in charge thereof shall be licensed.

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

Sec. 1. Within sixty days after this act shall take effect the Commissioner of Labor of the State of New Jersey shall establish in the Department of Labor a bureau to be known as the Steam Engine and Boiler Operators' License Bureau, to consist of three persons, citizens of the State of New Jersey, each of whom shall have been engaged for at least ten years in the occupation either as engineer in charge of a steam plant of not less than two hundred and fifty horsepower, or as the inspector for a steam engine and boiler insurance company licensed to do business within the said State, and who shall also be approved by the Civil Service Commission of this State. Each of the said persons constituting said bureau shall hold office for three years, their term of office expiring on the first day of May, excepting, however, those first appointed, one of whom shall be appointed until the first day of May, then ensuing; another until the first day of the May succeeding the term of the one first appointed; another until the first day of the May succeeding the term of the second one appointed, in order that the term of office of one of those appointed may expire on the first day of May of each year. Any vacancy occurring in the membership of the said bureau shall be filled by the Commissioner of Labor from persons properly qualified as aforesaid for the unexpired term.

Sec. 2. Each person appointed a member of said bureau shall, before entering upon the discharge of his duties and within thirty days after he has been appointed, take and subscribe to an oath before any officer authorized to administer oaths in this State, for the faithful performance of his duty,

which shall be filed with the said Commissioner of Labor and transmitted by him to the Secretary of State. They shall from time to time select one of their number for chairman. They may adopt all necessary rules, regulations and by-laws for their government not inconsistent with the laws of this State or of the United States, and shall prescribe rules for the examination and licensing of engineers and firemen in charge of stationary and portable steam boilers and steam engines within the State, and to prevent the use of such steam boilers and steam engines unless the person in charge shall hold such license. Such regulations shall also specify the terms and conditions under which such license shall be issued or renewed; to fix the fees charged for the issuance and renewal of such license; to provide for the revoking, for proper cause, of any license issued, all of which shall be subject to approval of the said commissioner and any of which may be revoked or annulled at any time by him. They shall report from time to time to the commissioner and in such form as he shall prescribe. All licenses recommended by them shall be issued under the hand and seal of the commissioner and a record thereof kept in his office.

Sec. 3. The provisions of this act shall not be construed to include or apply to any person in charge of or operating a steam boiler or steam engine under the control of the government of the United States, or any steam boiler used in railroad locomotives, or road vehicles, or in connection with the fire department of any municipality or public body of this State, or any steam boiler used exclusively for heating purposes, which boiler does not carry a pressure of more than ten pounds per square inch, nor shall it apply to any person holding a United States Marine License.

Sec. 4. Within sixty days after said bureau shall have been organized no person subject to the provisions of this act shall operate any steam boiler or steam engine without having a license herein provided for, except in case of emergency, and then for no longer than thirty days, of which emergency the owner of such steam boiler or steam engine, or the agent, superintendent or manager in charge thereof shall promptly notify such bureau in writing, stating briefly the circumstances in connection with such emergency.

Sec. 5. Application for license shall be made on blanks to be provided for that purpose by the bureau and shall state clearly the name, residence, age, color and nationality of the applicant, whether or not he is a citizen of the United States, and his previous experience as engineer or fireman.

Sec. 6. The fee for such examination and license shall be at the rate fixed by the said commissioner, not more than two dollars. Any license so issued may be revoked by the commissioner for ignorance, neglect or intoxication upon duty, after notice to the holder thereof and a hearing afforded him before the said bureau. In case such revocation be recommended by said bureu, it shall not be acted upon by said commissioner until at least five days' notice of such recommendation shall be given the person holding such license and an opportunity afforded him to ask for a rehearing before the commissioner. After such rehearing, if allowed, the commissioner may either comply with or dismiss such recommendation, or in a proper case, may suspend for a limited time such license.

Sec. 7. No engineer or fireman actually in charge of any steam boiler engine at the time this act takes effect, shall be required to take the examination required by this act, but shall receive a license as such engineer or fireman from the said commissioner upon the written request of the owner of the boiler or engine upon which he is engaged or by the agent, superintendent or manager of such owner, which application shall be made, however, within the time herein fixed for such examination.

Sec. 8. The form of license so as aforesaid to be issued shall be in such manner as the Commissioner of Labor shall approve.

Sec. 9. Each member of the bureau shall be entitled to have and receive as and for his compensation the sum of twelve hundred dollars per year, payable monthly, in the same manner as the compensation of other employees of the said Department of Labor. The fees received by the commissioner for such licenses shall be paid into the State Treasury.

Sec. 10. Any person so appointed a member of the said bureau may be removed by the said commissioner for sufficient cause the same as any other person in the Department of Labor appointed by him.

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The demand for anthracite coal fell off in the shipments during March, which were 1,660,399 tons less than those of March, 1912. In March, 1912, the shipments were 6,569,687 tons; in March, 1913, 4,909,288. The coal at shipping ports was 484,270 tons on Feb. 28, and 772,115 at the close of March, an increase of 287,845 tons.

Towne Scientific School Students' Trip

The first annual inspection trip of the senior students of the Towne Scientific School, University of Pennsylvania, was made during the Easter recess, Mar. 20 to 29, under the leadership of Prof. R. H. Fernald, the new head of the mechanical engineering department. The trip included Pittsburgh, Cleveland, Toledo, Niagara Falls, Schenectady and New York City.

Two days were spent at Pittsburgh and vicinity in visiting the plants of the Westinghouse Machine Co., the Westinghouse Electric & Manufacturing Co., the Jones & Laughlin Steel Co., the National Tube Co., at McKeesport, and the large mine of the Pittsburgh-Buffalo Co., at Marianna, Penn.

In Cleveland the new Lake Shore station of the Cleveland Electric Illuminating Co. and the city pumping station at Kirtland St. were inspected. The Peerless Motor Car Co. entertained the party by a sight-seeing trip through the suburbs and after its plant at East Ninety-third St. was inspected, the company acted as host at a luncheon to the students. The stay at Cleveland was concluded by a trip through the plant of the National Carbon Co.

At Toledo the attractions were the gas-engine driven filtration plant on the Maumee River and the Edward Ford Plate Glass Co.

The Niagara Falls Power Co. plants, Nos. 1 and 2, the International Paper Co., the Shredded Wheat Biscuit Co., and the Ontario Power Co. were visited at Niagara Falls. Owing to delays on the road because of floods, the trip through the General Electric Works at Schenectady had to be made very hurriedly in order to get to New York City.

The first day in New York was spent in the Waterside plants of the New York Edison Co. and the Fifty-ninth St. Station of the Interborough Rapid Transit Co. The trip ended with a visit to the Singer Building, the Pennsylvania R.R. Terminal and the Hotel Astor.

Though hampered considerably by floods, the trip was considered such a complete success that it is expected it will be made compulsory in the course of another year or two.

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Mechanical Engineers Meet at New Haven

On the afternoon and evening of Apr. 16, the local branch of the American Society of Mechanical Engineers at New Haven met at the Mason laboratory of the Sheffield Scientific School. These meetings have been held twice a year, and as usual there was a good attendance.

In the afternoon the subject was "Factory Heating and Ventilation." A. C. Staley, of the mechanical engineering department, presented the introductory paper, which was an elementary lantern-slide treatment of types of system and apparatus. Starting with the ordinary stove and hot-air furnace, the discussion led up to direct heating by steam and hot water. The different arrangements of piping and the apparatus employed were shown, and the same was done with hot-blast and indirect heating, with some attention to cleaning the air and obtaining the proper humidity.

G. H. Miller, of Cheney Bros., South Manchester, followed with a description of the system covering the company's various mills. Different systems using steam at different pressures had formerly been employed in the various buildings. The entire system has now been unified and all buildings receive steam reduced from 125 to 5 lb. pressure from a common source. A vacuum pump is located in each building rather than at the central plant. The longest run is about 1300 ft., and with a 10-in vacuum at the pump the operation of the system as a whole has been satisfactory. In some of the buildings direct radiation is used and in others, hot-blast heating, with provision for cleaning and adding moisture to the air.

W. G. Snow talked Webster vacuum and pressure systems with particular reference to the Modulation and Sylphon valves.

James A. Donnelly outlined the method of testing radiator valves recently adopted by the New York chapter of the American Society of Heating and Ventilating Engineers.

Other speakers were W. F. Goodnow, on Vento radiation, Mr. Pryor, of the Carrier Co., on air washing, and W. J. Baldwin on the proper temperature and humidity which should be maintained in a room.

Intermission gave an opportunity to view a special exhibit of gas arc and other types of gas lamps and, of course, the general equipment of the laboratory.

Clarence E. Clewell, instructor in electrical engineering, introduced the subject of the evening with a paper on "Factory Lighting." Some interesting discussion closed a very successful meeting.

Heating Engineers to Meet at Indianapolis

The fifth annual convention of the National District Heating Association will be held in Indianapolis, Ind., on Tuesday, Wednesday and Thursday, May 27, 28 and 29, 1913. The headquarters of the convention will be the Claypool Hotel, where the sessions will be held, and in the convention room space will be reserved for the exhibits. Besides the various reports of committees, the following papers have been outlined: "Hot-Water Heating for Residence Districts," A. C. Rogers; "Possibilities of Hot-Water Heating," N. M. Argabrite; "District Heating on the Pacific Coast," Charles F. Murphy; "Discussion on the Use of Bleeder Turbines," by the users; "Commission Control of Utilities," D. L. Gaskill; "Appraisal of Heating Properties," Harold Almert; "Station Designs with Special Reference to Overload Capacities." Mr. Denman; "Is District Heating Profitable to the Central Station?" C. J. Davidson; "Operating Economics in Heating Large Factory Buildings," Edward L. Wilder.

New Jersey N. A. S. E. State Convention

The convention committee of the New Jersey State N. A. S. E. for the coming state convention in Newark, May 22, to 25, reports unusually good results in the sale of booths; 83 out 132 having been sold up to Apr. 16.

This year's convention promises to be even more successful than those of former years, and the committee is making preparations for caring for unusually large crowds. The convention hall will be found very convenient for exhibitors, and as the floor level is only 18 in. above the street, the moving of heavy machinery will be simple and inexpensive.

SOCIETY NOTES

The annual meeting of the Iron and Steel Institute will be held at the Institution of Mechanical Engineers, at London, on May 1 and 2. During the second day's session the Andrew Carnegie gold medal (for 1912) will be presented to J. Newton Friend, Ph. D., and the awards of research scholarships for the current year will be announced. Some fourteen papers are expected to be read and discussed. The autumn meeting will be held at Brussels, Sept. 1 to 5.

It is announced that the thirteenth annual six weeks summer school of the College of Engineering of the University of Wisconsin will open on June 23. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shopwork and surveying, in addition to which subjects may be taken in the College of Letters and Science. For a bulletin, address F. E. Turneaure, University of Wisconsin, Madison, Wis.

The April meeting of the Massachusetts Chapter of the American Society of Heating and Ventilating Engineers at Boston, was devoted to a general discussion of breaks in radiators. It was found that certain designs of the wall type of cast-iron radiator were known to break, after installation, caused by the strain not being properly taken care of or equalized in the design. The method of installing and hanging was also taken up and several specific cases were explained, but it was the opinion of the engineers that this trouble was chiefly due to the faulty design of the radiator. A general discussion of air conditioning at the Museum of Fine Arts followed, Mr. MacLean, its superintendent, explaining at length the installation, the effect and general benefits.

PERSONALS

T. T. Burchfield has assumed the Philadelphia agency of A. L. Ide & Sons, Springfield, Ill.

W. E. Wolmagott, city electrician of Peoria, Ill., has been elected president of the Peoria Electrical Club.

James D. Apdrew has resigned from the Boston Elevated Ry. Co. to become superintendent of power stations for the Boston Edison Co.

I. E. Moultrop, formerly mechanical engineer of the Boston Edison Co., has been promoted to the position of assistant superintendent of construction.

W. H. Tees, formerly chief electrician of the Canadian Consolidated Rubber Co., Montreal, Que., and is now assistant superintendent of the Sayer Electric Co., of Montreal.

Elmer Iverslin has succeeded P. B. Renther as chief engineer of the municipal electric-lighting plant at Belgrade, Minn., and will also act as manager and superintendent.

Eugene L. Barnes has taken charge as district manager of the newly opened Pacific Coast offices of the American District Steam Co., North Tonawanda, N. Y., in the Hoge Bldg., Seattle, Wash.

Harry B. Aller, who for two years was out of the steam specialty field, is now representing the Ashton Valve Co. in Illinois, Wisconsin, Minnesota and Missouri. Mr Aller will make Chicago his headquarters.

Clark, MacMullen & Riley, Inc., consulting engineers for the design of heating, ventilating and electrical equipments, formerly at 80 Maiden Lane, now have their offices in the Architects' Building, 101 Park Ave., New York City.

Prof. Henry H. Norris, of the department of electrical engineering, Cornell University, and secretary of the Society for the Promotion of Engineering Education, is devoting a leave of absence to a special investigation of engineering books in all fields for the McGraw-Hill Book Co., New York. His work will cover both college textbooks and general technical reference books.

NEW EQUIPMENT

ATLANTIC COAST STATES

Plans are being prepared by the Fall River Electric Co., Fall River, Mass., for an expenditure of $200,000, for extensions and equipment for its plant. A. H. Kimball, Fall River, is general manager and purchasing agent.

The Corning Light & Power Co., which recently acquired the property of the Corning Gas & Electric Co., will construct a new power plant at Corning, N. Y.

The Commonwealth Water & Light Co. will expend $20,000 for extensions and improvements to the power plant of its subsidiary company at Lakewood, N. J.

Plans have been prepared for the construction of a power plant on 19th St. and Allegheny Ave., Philadelphia, Penn., for the Storage Battery Co.

SOUTHERN STATES

An election will be held on May 6 to vote on the proposition to issue $25,000 in bonds for the installation of a waterworks system at Cherryville, N. C.

The proposition to issue $20,000 in bonds for the construction of a municipal electric-light plant at Washington, N. C., is under consideration.

Bonds for $8000 have been voted for the construction of a municipal electric-light plant at Abbeville, Ga.

Plans are being prepared for the improvement and extension of the municipal electric-light plant at Quitman, Ga.

It is proposed to issue $20,000 in bonds for the improvement of the municipal electric-light plant at Roanoke, Ala.

The city council of Estherwood, La., is considering the proposition to construct a municipal electric-light plant.

Plans are being prepared by Henry A. Mentz, Randolph Bldg., Memphis, Tenn., for the construction of a municipal water-works system at Dresden, Tenn. Estimated cost, $15,000.

The city council of Henderson, Tenn., has been authorized to issue $50,000 in bonds for the construction of a municipal electric-light plant and water system.

CENTRAL STATES

Plans are being considered by the Factory Power Building, Oakley, Cincinnati post-office, Ohio, for the construction of an addition to its power plant, for the purpose of supplying 500-hp. in addition to the energy now produced. Zettel & Rapp are architects.

Bids will be received by the board of trustees of public affairs of Paulding, Ohio, until Apr. 29, for the installation of new equipment in the municipal electric-light and water plant. J. F. Morrissey is president of the board.

Bids will be received by J. W. Sanderson, treasurer of the Marin Branch of the National Home for Disabled Volunteer Soldiers, until May 2, for the installation of new equipment and the improvement of the power plant at National Military Home, Ind.

The proposition to construct a municipal electric-light plant at Alton, Ill., is under consideration. J. F. Schwaab is city engineer.

The Piasa Light & Power Co. will construct a substation at Alton, Ill. Roy Holden is manager.

Plans are being considered by the village authorities of Deer Park, Wis., for the construction of an electric-light plant.